ASSOCIATED ATTACHMENTS/ENCLOSURES:

Attachment 02.04.03-09B: CDQ000020080021, Rev. 0, Initial Dam Rating Curve - Wheeler

(278 Pages including Cover Sheet)

NPG CALCULATION COVERSHEET/CCRIS UPDATE

REV 0 EDMS/RIMS NO.	EDMS TYPE:	EDMS ACCESSION NO (N/A for REV. 0)
L58 091023 002	Calculations (nuclear)	N/A

Calc Title: Initial Dam Rating Curve, Wheeler

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	CUR REV	NEW REV	REVISION APPLICABILITY
CURRENT	CN	NUC						Entire calc ☐ Selected pages ☐
NEW	CN	NUC	GEN	CEB	CDQ000020080021	N/A	0	

ACTION: NEW ☒ REVISION ☐ | DELETE ☐ RENAME ☐ | SUPERSEDE ☐ DUPLICATE ☐ | CCRIS UPDATE ONLY ☐ (Verifier Approval Signatures Not Required) | No CCRIS Changes ☐ (For calc revision, CCRIS been reviewed and no CCRIS changes required)

UNITS	SYSTEMS	UNIDS
N/A	N/A	N/A

DCN,EDC,N/A	APPLICABLE DESIGN DOCUMENT(S)	CLASSIFICATION
EDCN 22404A (SQN) EDCN 54018A (WBN) LATER (BFN)	N/A	E

QUALITY RELATED?	SAFETY RELATED? (If yes, QR = yes)	UNVERIFIED ASSUMPTION	SPECIAL REQUIREMENTS AND/OR LIMITING CONDITIONS?	DESIGN OUTPUT ATTACHMENT?	SAR/TS and/or ISFSI SAR/CoC AFFECTED
Yes ☒ No ☐	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒

PREPARER ID	PREPARER PHONE NO	PREPARING ORG (BRANCH)	VERIFICATION METHOD	NEW METHOD OF ANALYSIS
jbmauter	205-298-6074	CEB	Design Review	☐ Yes ☒ No

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
Janie B. Mauter *Janie B. Mauter*	10/16/09	Bryant Bondurant *Bryant Bondurant*	10/16/09
VERIFIER SIGNATURE	**DATE**	**APPROVAL SIGNATURE**	**DATE**
L. Y. Lin *L. Lin*	10/16/09	P. B. Selman *PBSelman for K.R.Spates* (dos 10/21/09; Per PBS 10/21/09 per telecon)	10/23/09

STATEMENT OF PROBLEM/ABSTRACT

An initial headwater rating curve for Wheeler Dam is required as input to TVA's SOCH and TRBROUTE models, which perform flood-routing calculations for the Tennessee River and its tributaries. The headwater rating curves for each dam provide total dam discharge as a function of headwater elevation. This calculation presents an initial headwater rating curve for Wheeler Dam.

This calculation contains electronic attachments and must be stored in EDMS as an ADOBE.PDF file to maintain the ability to retrieve the electronic attachments.

MICROFICHE/EFICHE Yes ☐ No ☒ FICHE NUMBER(S)

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NPG CALCULATION COVERSHEET/CCRIS UPDATE

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	REV
	CN	NUC	GEN	CEB	CDQ000020080021	0

ALTERNATE CALCULATION IDENTIFICATION

BLDG	ROOM	ELEV	COORD/AZIM	FIRM	Print Report Yes ☐
				BWSC	

CATEGORIES NA

KEY NOUNS (A-add, D-delete)

ACTION (A/D)	KEY NOUN	A/D	KEY NOUN
A	Dam		
A	Curve		
A	Discharge		
A	Spillway		
A	PMF		

CROSS-REFERENCES (A-add, C-change, D-delete)

ACTION (A/C/D)	XREF CODE	XREF TYPE	XREF PLANT	XREF BRANCH	XREF NUMBER	XREF REV
A	P	IO	GEN	CEB	Spillway Discharge Tables	
A	P	DW	GEN	CEB	10W200	0
A	P	DW	GEN	CEB	232-D-723	
A	P	DW	GEN	CEB	232-D-455	
A	P	DW	GEN	CEB	232-D-692	
A	P	DW	GEN	CEB	51N4200	3
A	P	DW	GEN	CEB	64N201	2
A	P	DW	GEN	CEB	61N250	7
A	P	DW	GEN	CEB	61N501	3
A	P	DW	GEN	CEB	232-D-729	4
A	P	DW	GEN	CEB	232-D-721	3
A	P	DW	GEN	CEB	61N506	2
A	P	DW	GEN	CEB	02-L3 20/2	7
A	P	DW	GEN	CEB	232-D-728	
A	P	DW	GEN	CEB	232-D-917	
A	P	DW	GEN	CEB	232-D-452	
A	P	DW	GEN	CEB	64N202	2
A	P	DW	GEN	CEB	232-D-817	
A	P	DW	GEN	CEB	232-D-540	
A	P	DW	GEN	CEB	232-D-2721	

CCRIS ONLY UPDATES:
Following are required only when making keyword/cross reference CCRIS updates and page 1 of form NEDP-2-1 is not included:

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
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NPG CALCULATION COVERSHEET/CCRIS UPDATE

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	REV
	CN	NUC	GEN	CEB	CDQ000020080021	0

ALTERNATE CALCULATION IDENTIFICATION

BLDG	ROOM	ELEV	COORD/AZIM	FIRM	Print Report Yes ☐
				BWSC	

CATEGORIES NA

KEY NOUNS (A-add, D-delete)

ACTION (A/D)	KEY NOUN	A/D	KEY NOUN

CROSS-REFERENCES (A-add, C-change, D-delete)

ACTION (A/C/D)	XREF CODE	XREF TYPE	XREF PLANT	XREF BRANCH	XREF NUMBER	XREF REV
A	P	DW	GEN	CEB	232-D-2111	
A	S	CN	GEN	CEB	CDQ000020080042	
A	S	CN	GEN	CEB	CDQ000020080046	
A	S	CN	GEN	CEB	CDQ000020080053	
A	S	CN	GEN	CEB	CDQ000020080054	
A	P	DN	SQN	CEB	22404	
A	P	DN	WBN	CEB	54018	

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PREPARER PHONE NO.	EDMS ACCESSION NO.		

NPG CALCULATION RECORD OF REVISION	
CALCULATION IDENTIFIER: CDQ000020080021	
Title	Initial Dam Rating Curve, Wheeler
Revision No.	DESCRIPTION OF REVISION
0	Initial issue: 44 pages

NPG CALCULATION TABLE OF CONTENTS

Calculation Identifier: CDQ000020080021	Revision: 0	

TABLE OF CONTENTS

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List of Acronyms	
BLN	Bellefonte Nuclear Plant
BFN	Browns Ferry Nuclear Plant
COLA	Combined Operating License Application
FSAR	Final Safety Analysis Report
NEDP	TVA Standard Department Procedure
PMF	Probable Maximum Flood
SOCH	Simulated Open Channel Hydraulics
SQN	Sequoyah Nuclear Plant
TVA	Tennessee Valley Authority
TRBROUTE	Tributary Routing Model
USACE	United States Army Corps of Engineers
WBN	Watts Bar Nuclear Plant
List of Variables	
C_f	Free discharge coefficient
C_g	Orifice discharge coefficient
d	Difference between height of tailwater and elevation of crest
g	Acceleration due to gravity
G	Effective gate opening
H_c	Head on crest
H_g	Minimum gross head on turbines
H_{Lmin}	Head at which the overflowing nappe first touches the bottoms of the open gates
H_{mp}	Vertical distance between the mid-point of G and the headwater elevation
HW	Headwater elevation
HW_{max}	Upper limit on headwater elevation for rating
L	Length of overflowing section
Q_f	Free discharge
Q_g	Orifice discharge
Q_{Tmax}	Maximum turbine discharge
S_g	Submergence factor for tailwater
TW	Tailwater elevation
V	Vertical opening of spillway gate
Z_c	Crest elevation of overflowing section

NPG COMPUTER INPUT FILE STORAGE INFORMATION SHEET

Document CDQ000020080021	Rev. 0	Plant: GEN	

Subject: Initial Dam Rating Curve, Wheeler

☐ Electronic storage of the input files for this calculation is not required. Comments:

There is no electronic input or output files associated with this calculation.

☒ Input files for this calculation have been stored electronically and sufficient identifying information is provided below for each input file. (Any retrieved file requires re-verification of its contents before use.)

These files are electronically attached to the parent ADOBE.PDF file. All files are therefore retrievable through the EDMS number.

Attachment 1: 10W200R0.pdf
Attachment 2: HDC711.pdf
Attachment 3: Method for Estimating Discharge.pdf
Attachment 4: Tainter Gate Rating Data.pdf
Attachment 5: WheelerBlueBook.pdf
Attachment 6: WheelerSpillwayDischargeTables.pdf
Attachment 7: WheelerTW.xls
Attachment 8: Wheeler.xls
Attachment 9: DamSpillwayGateOpenBasis Rev0.pdf
Attachment 10: LockGateTechnicalEvaluationWhitePaper.pdf
Attachment A1: Discharge Coefficients.pdf
Attachment A2: 232-D-723.pdf
Attachment A3: 232-D-455.pdf
Attachment A4: HDC311.pdf
Attachment A5: 232-D-728.pdf
Attachment B1: 02-L3-20-2R7.pdf
Attachment B2: 51N4200R3.pdf
Attachment B3: 61N250R7.pdf
Attachment B4: 61N501R3.pdf
Attachment B5: 61N506R2.pdf
Attachment B6: 64N201R2.pdf
Attachment B7: 232-D-452.pdf
Attachment B8: 232-D-692.pdf
Attachment B9: 232-D-721R3.pdf
Attachment B10: 232-D-729R4.pdf
Attachment B11: Rating Curves for Flow over Drum Gates.pdf
Attachment B12: 232-D-2111.pdf
Attachment B13: 232-D-917.pdf
Attachment B14: 64N202R2.pdf
Attachment B15: 232-D-817.pdf
Attachment B16: 232-D-540.pdf
Attachment B17: 232-D-2721.pdf

☐ Microfiche/eFiche

1. Purpose

An initial headwater rating curve for Wheeler Dam is required as input to TVA's SOCH and TRBROUTE models, which perform flood-routing calculations for the Tennessee River and its tributaries. The headwater rating curves for each dam provide total dam discharge as a function of headwater elevation. This calculation presents the initial headwater rating curve for Wheeler Dam. The final headwater rating curve will be developed during the PMF modeling.

TVA developed methods of analysis, procedures, and computer programs for determining design basis flood levels for nuclear plant sites in the 1970s. Determination of maximum flood levels included consideration of the most severe flood conditions that may be reasonably predicted to occur at a site as a result of both severe hydrometerological conditions and seismic activity. This process was followed to meet Nuclear Regulatory Guide 1.59. At that time, there were no computer programs available that would handle unsteady flow and dam failure analysis. As a result of this early work and method development, TVA developed a runoff and stream course modeling process for the TVA reservoir system. This process provided a basis for currently licensed plants (Sequoyah Nuclear Plant, Watts Bar Nuclear Plant, and Browns Ferry Nuclear Plant). The Bellefonte Nuclear Plant (BLN) Units 1 & 2 Final Safety Analysis Report (FSAR) was also based on this process.

BLN Units 3 & 4 Combined Operating License Application (COLA) was submitted using data and analysis that was determined for the original BLN FSAR (Unit 1 and Unit 2) and was documented in a 1998 reassessment. In 1998, the analysis process and documentation was brought under the nuclear quality assurance process for the first time. A quality assurance audit conducted by NRC staff in early 2007 raised several questions related to the documentation of past work regarding design basis flood level determinations. This calculation supports a portion of the effort to improve this design basis documentation.

Preparation of all calculations supporting nuclear development and licensing are subject to TVA Standard Department Procedure NEDP-2. This standard dictates the process in which calculations are prepared, checked, verified, stored, and cross referenced in a goal to provide the highest quality nuclear design input and output possible.

Figure 1 is a plan and elevation view of Wheeler Dam (Reference 2.1). For headwaters in the normal operating range, discharge is passed through the turbines or the spillway. The spillway consists of sixty (60) spillway bays, each with radial or tainter gates to control discharge. If, as during a probable maximum flood (PMF) event, headwater rises above the normal operating range, discharge may also pass over the navigation locks, nonoverflow sections, trashway, top of the trashway piers, powerhouse, and various roadway sections. The dam rating curve contained in this calculation considers the effects of all listed overflow points with their respective elevations and overflow parameters.

The dam rating curve is based on the current configuration of Wheeler Dam as defined on the current design drawings. The purpose of this calculation does not evaluate the design loading conditions for the dam or embankments.

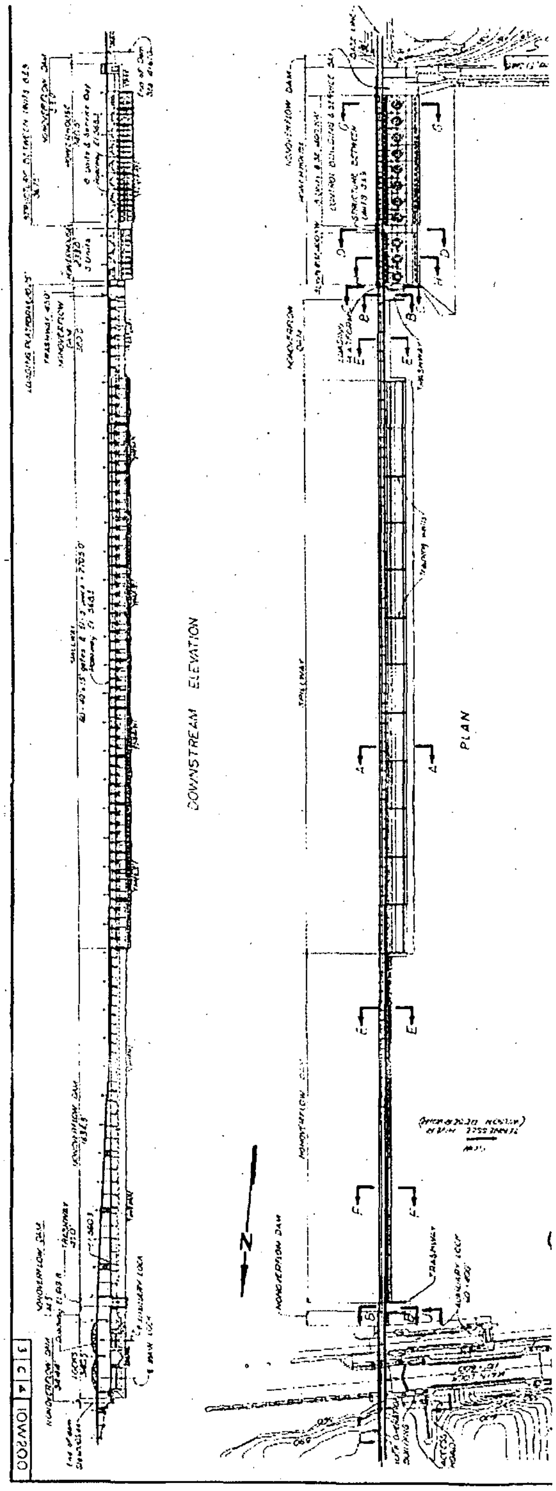

Figure 1 – Wheeler Dam General Plan and Elevation (Reference 2.1)

2. References

2.1. TVA Drawing No. 10W200 R0 (Attachment 1).

2.2. TVA Water Control Project Manual (Blue Book) for Wheeler Dam, TVA River Systems Operations, October 1999 (Attachment 5).

2.3. "Wheeler Dam Spillway Discharge Tables," River Systems Operations, Tennessee Valley Authority, 2004 (Attachment 6).

2.4. "Hydraulic Design Criteria," Hydraulic Design Chart 711 (HDC 711), USACE (U.S. Army Engineer Waterways Experiment Station), Eighteenth issue, Vicksburg, MS, 1988 (Attachment 2).

2.5. "Tainter Gate Rating Data Determined from Eight TVA Model Studies," Tennessee Valley Authority, Division of Water Control Planning, 1962, EDMS No. L58 080821 001 (Attachment 4).

2.6. "Method for Estimating Discharge at Overflow Spillways with Curved Crests and Radial Gates," Tennessee Valley Authority, Office of Natural Resources and Economic Development, Report No. WR28-2-900-123, 1985 (Attachment 3).

2.7. "Basis for Dam Spillway Gate/Outlet Open Configuration for Flood Analyses," Tennessee Valley Authority, 2009, EDMS No. L58 090529 800 (Attachment 9).

2.8. "Dam Lock Gate Technical Evaluation for the PMF," Tennessee Valley Authority, 2009, EDMS No. L58 090908 001 (Attachment 10).

2.9. "Design of Small Dams," U.S. Department of the Interior, U.S. Government Printing Office, 1987.

3. Assumptions & Methodology

The headwater rating curves developed in this calculation will be used in simulations of probable maximum flood (PMF) events. Consequently, the rating curves have been calculated well above the normal operating range.

3.1 Assumptions

3.1.1 Assumption: Power generation will continue during a PMF event until the switchyard is flooded.
Technical Justification: Power generation is assumed to stop when the tailwater reaches an elevation of 514.8 feet, at which point water will enter the switchyard (Reference 2.1). Turbine discharge will be considered for rising headwaters until the tailwater reaches an elevation of 514.8 feet. After the switchyard has been flooded, the generator will not be restarted because electrical components will be wet. Therefore, turbine discharge is not included as headwaters fall after flooding of the switchyard.

3.1.2 Assumption: The elevation of the main lock gate overflow is 560.58 feet.
Technical Justification: The main lock gate overflow elevation is listed as 560.58 feet in the Blue Book (Reference 2.2). However, on drawing 10W200R0 (Reference 2.1) the main lock gate overflow is shown as 560.38 feet. Without conducting an extensive investigation into the differences, an elevation of 560.58 feet will be used because it is more conservative by decreasing the total dam discharge.

3.1.3 Assumption: Both gate leaves will remain closed for both trashways during a PMF.
Technical Justification: This assumption is conservative for predicting flood levels at Browns Ferry Nuclear Plant since a closed trashway decreases the total dam discharge.

3.1.4 Assumption: The tailwater rating curve (Attachment 7) is sufficient for computing submergence effects on the headwater rating curve.
Technical Justification: This curve was produced by TVA's River Systems Operations Flood Risk Group and is used as the best available information. As shown in the following calculation, tailwater does not affect the discharge past Wheeler Dam. Therefore, the tailwater rating curve has no effect on the headwater rating curve and can be used.

3.1.5 Assumption: All spillway gates will be set to the maximum openings specified in the Spillway Discharge Tables (Reference 2.3).
Technical Justification: A TVA position paper justifying the operability of the gates in included as Reference 2.7.

3.1.6 Assumption: The upper gates of the navigation locks will not fail during PMF overflow.
Technical Justification: A TVA position paper justifying the operability of lock gates located upstream of Wheeler is included as Reference 2.8. Based on the evaluation made for other upstream lock gates, the Wheeler lock gates are expected to maintain position. However, should the lock gates fail, the flood levels at Browns Ferry will be decreased from that predicted in the PMF analysis and is therefore conservative.

3.1.7 Assumption: The fully raised spillway tainter gates will remain in their open position when flow passes over the spillway piers and the tops of the gates.
Technical Justification: Appendix C contains hydrostatic loads on the tainter gates. According to the calculations, there is a possibility that the open tainter gate may fail at the PMF level. However, it is conservative to assume that the gates will not fail.

3.2 Unverified Assumptions (UVA)

None.

3.3 Methodology – Discharge Equations

Discharges past the dam are computed as either free discharge or orifice discharge. Free discharge refers to free surface overflow and is computed using a weir-type equation as follows (Reference 2.6 shows weir flow equations for overflow discharges):

$$Q_f = C_f L H_c^{1.5} \qquad \text{(Equation 1)}$$

in which variables are defined as follows:
Q_f = free discharge (cfs)
C_f = free discharge coefficient (may vary with HW)
L = length of overflowing section (ft)
H_c = head on crest (ft) = HW – Z_c
HW = headwater elevation (ft)
Z_c = top, or crest, elevation of overflowing section (ft)
This equation need not be modified to account for tailwater submergence, as no portion of the dam which has free surface overflow is expected to be submerged by tailwater.

Flow over the nonoverflow sections is treated as free discharge. Flow over the spillway crest is treated as free discharge for headwater elevations below $H_c = H_{Lmin}$, the head at which the overflowing nappe first touches the bottoms of the open gates (Appendix A). H_{Lmin} varies with gate opening, V, defined as the vertical distance between the bottom of the wide-open gate and the surface of the spillway crest directly below the gate lip.

For headwater elevations above $H_c = H_{Lmin}$, flow through the spillway gates is treated as orifice discharge, and for headwater elevations above the bottom of the roadway, flow over the nonoverflow sections is treated as orifice discharge. Orifice discharge refers to flow passing through a contracted opening and is computed using an orifice-type equation as follows (Reference 2.6):

$$Q_g = C_g G L \sqrt{2g(H_c - H_{mp})} \qquad \text{(Equation 2)}$$

in which variables are defined as follows:
Q_g = orifice discharge (cfs)
C_g = orifice discharge coefficient (varies with gate opening and H_c)
G = effective gate opening (ft)
g = acceleration due to gravity (ft/s^2)
H_{mp} = vertical distance between the mid-point of G and the headwater elevation (ft)

This equation need not be modified to account for tailwater submergence. The tailwater submergence factor, S_g, varies with d/H_c and effective gate opening, G, where d = TW – Z_c (ft) and TW = tailwater elevation (ft). Attachment 2 indicates tailwater effects are not significant until d/H_c (see definition sketch, Appendix A) approaches a value of 0.6. Calculation of d/H_c during headwater rating confirms that tailwater effects can be neglected.

3.4 Methodology – Spillway Discharge Calculations

The discharge coefficient, C_f, for free discharge over a spillway crest varies with head, H_c. For the Wheeler spillway crest, the relationships $H_{Lmin}(V)$ and $C_f(H_c)$ are available from model test data (Reference 2.5). The relationship between orifice discharge coefficient, C_g, and head, H_c, for various gate openings, V (up to V = 13 feet), is also available from the model test data. The crest length, L, and crest elevation, Z_c, are shown on TVA drawings (e.g., Reference 2.1). The parameters G and H_{mp} are determined from geometry (Appendix A). The physical model used to measure spillway discharge included several bays and the piers between them. Consequently, pier contraction effects are implicitly included in the discharge coefficients derived from the model test data.

Under the assumption that all spillway gates are fully open, the two end bays (first and last) are the only spillway bays subject to end contraction effects. These effects, which may reduce discharge through these two bays by a few percent, are neglected in this calculation. Neglecting this minor effect has negligible impact on the dam rating curve.

3.5 Methodology – Nonoverflow Discharge Calculations

The discharge coefficient, C_f, for free discharge over a nonoverflow section varies with H_c/B. The relationship between C_f and free discharge is shown as Equation 1. The relationship between the orifice discharge coefficient, C_g and d/H_1 can be found in Reference 2.9. The orifice discharge equation is determined from Reference 2.6 and is shown as Equation 2. The nonoverflow length, L, and elevation, Z_c, are determined from TVA drawings (e.g., Reference 2.1). The parameters are defined in Appendix B.

3.6 Methodology – Discharge Coefficients

Values of the discharge coefficient, C_f, for flows over the main lock gate, lock walls, powerhouse, and roadway are estimated using Hydraulic Design Chart 711 (Reference 2.4). C_f for flows over the auxiliary lock gate, the top of the closed trashway gate, the top of the trashway piers, and the nonoverflow sections will be 3.33, a constant for sharp-crested weirs (Reference B17). Calculations of the values of the discharge coefficient can be found in Appendix B. Length, L, and crest elevation, Z_c, in each case are determined from TVA drawings (all relevant drawings are defined as References).

The upper plot of HDC 711 shows that C_f is about 2.65 for very broad crests ($H_1/B < 0.4$ where $H_1 = H_c$ and B = streamwise length of the crest) and gradually increases to 3.1, the maximum value for a "broad-crested" weir, as H_1/B increases to about 1.2. As H_1/B increases above 1.2, C_f continues to increase as the weir transitions from broad-crested to sharp-crested at about $H_1/B = 2.0$. Since the estimation of discharge over the top of various sections of a dam and its embankments is an approximation, small variations in C_f with H_c are not modeled and the effects of end contractions are neglected. A single representative value for C_f within the range of its variation is used for all headwater elevations included in the rating. Neglecting minor variations in C_f values and end contractions has negligible impact on the dam rating curve.

3.7 Methodology – Turbine Discharge

The elevation of the switchyard is such that the tailwater will not impede its operation until significant headwater levels are reached (i.e. flows of over 840,000 cfs). The Units 1-8 Operating Characteristics and Units 9-11 Operating Characteristics sheets from the Wheeler Blue Book (Reference 2.2, Attachment 5), pages 39-47, provide the turbine discharge based on the gross head for the dam. The gross head is the difference between the headwater elevation and the tailwater elevation. The lowest gross head shown in Reference 2.2 is 38 feet. Turbine discharge for lower values of gross head would be determined by extrapolation. The following table summaries the iterative steps to determine the turbine discharge for a range of headwater values.

HW	Spillway Discharge (cfs)	Estimated Turbine Discharge (cfs)	Estimated Total Discharge (cfs)	TW	Gross Head	Turbine Discharge for 44' Gross Head	Total Discharge
550	219,042	101,200	320,242	508.62	41.38	117,625	336,667
552	307,087	101,200	408,287	508.89	43.11	117,625	424,712
554	407,988	101,200	509,188	509.46	44.54	117,625	525,613
556	520,511	101,200	621,711	510.58	45.42	117,625	638,136
558	640,383	101,200	741,583	512.49	45.51	117,625	758,008

The iteration to determine the turbine discharge is as follows:

1. The spillway discharge for the headwater elevations 550, 552, 554, 556, and 558 are taken from Table 1, page 19.
2. The tailwater elevations for headwater elevations 550, 552, 554, 556, and 558 are determined from Attachment 7, the tailwater rating curve, for the Estimated Total Discharge.
3. The gross heads (HW-TW) for the headwater elevations 550, 552, 554, 556, and 558 are calculated. A gross head of 44' is used to estimate the turbine discharge for all elevations.
4. The turbine discharge for 44' gross head is taken from drawings 47K904-1 R0 through 47K904-8 R0 and 47K4901 R0, from the Wheeler Blue Book (Reference 2.2, Attachment 5).
5. Finally, the total discharge is the sum of the spillway discharge and the turbine discharge for 44' gross head.

The turbine discharge continues until the tailwater reaches elevation 514.8 feet, the elevation at which the switchyard is flooded. Once stopped, the turbines are not expected to be restarted immediately when the tailwater drops below elevation 514.8 feet. Due to the flooding of the switchyard, the turbines may not operate for several days.

3.8 Methodology – Powerhouse

The elevation of the powerhouse and control building is 569.05 feet (Reference 2.1). Therefore, the powerhouse will be overtopped during a PMF event. Overflow from the powerhouse is included in the headwater rating curve and can be found in Appendix B.

3.9 Methodology – Roadway

The elevation for the roadway (including curb) is indicated at 569.05 feet for stations 4+67 through 50+38 and 569.65 for stations 4+67 through 51+73 (Reference 2.1). Therefore, the roadway will be overtopped and is considered in this headwater rating curve. Calculations can be found in Appendix B.

4. Design Input

Sect.	Input Parameter	Source	Symbol	Value
4.1	**Acceleration of Gravity**	Common Knowledge	g	32.2 ft/sec^2
4.2	**Spillway Crest Parameters**			
4.2.1	Crest Length	60, 40' wide bays, Ref. 2.2	L	2400 feet
4.2.2	Crest Elevation	Ref. 2.2	Z_c	541.3 feet
4.2.3	Free Discharge Coefficient	Computed in Appendix A	$C_f(H_c)$	Equation A3 and A4
4.3	**Spillway Gate Parameters**			
4.3.1	Vertical Opening	Computed in Appendix A	V	15.78 feet
4.3.2	Effective Gate Opening	Computed in Appendix A	G	15.83 feet
4.3.3	Mid-point Distance between Gate Opening, relative to crest	Computed in Appendix A	H_{mp}	7.88 feet
4.3.4	Headwater Elevation at which nappe touches gates	Computed in Appendix A	$H_{Lmin} + Z_c$	561.09 feet
4.3.5	Orifice Discharge Coefficient	Computed in Appendix A	$C_g(H_c)$	Points extrapolated from Table A3
4.4	**Trashway Overflow (Gates Closed)**			
4.4.1	Discharge Coefficient	Computed in Appendix B	C_f	3.33
4.4.2	Overflow Elevation	Ref. 2.1	Z_c	556.3 feet
4.4.3	Overflow Length	Ref. 2.2	L	75 feet
4.5	**Trashway Piers Overflow**			
4.5.1	Discharge Coefficient	Computed in Appendix B	C_f	3.33
4.5.2	Overflow Elevation	Computed in Appendix B	Z_c	567.51 feet
4.5.3	Overflow Length	Computed in Appendix B	L	20 feet
4.6	**Main Lock Gate Overflow**			
4.6.1	Discharge Coefficient	Computed in Appendix B	C_f	2.95
4.6.2	Overflow Elevation	Computed in Appendix B	Z_c	560.58 feet
4.6.3	Overflow Length	Computed in Appendix B	L	110.08 feet
4.7	**Auxiliary Lock Gate Overflow**			
4.7.1	Discharge Coefficient	Computed in Appendix B	C_f	3.33
4.7.2	Overflow Elevation	Computed in Appendix B	Z_c	558.30 feet
4.7.3	Overflow Length	Computed in Appendix B	L	60.08 feet
4.8	**Lock Walls Overflow – Section 1**			
4.8.1	Discharge Coefficient	Computed in Appendix B	C_f	2.65
4.8.2	Overflow Elevation	Computed in Appendix B	Z_c	566.72 feet
4.8.3	Overflow Length	Computed in Appendix B	L	172.92 feet
4.9	**Lock Walls Overflow – Section 2**			
4.9.1	Discharge Coefficient	Computed in Appendix B	C_f	2.65
4.9.2	Overflow Elevation	Computed in Appendix B	Z_c	562.30 feet
4.9.3	Overflow Length	Computed in Appendix B	L	18.76 feet
4.10	**Nonoverflow Section – Sta. 4+67 to 50+38**			
4.10.1	Discharge Coefficient	Computed in Appendix B	C_f	3.33
4.10.2	Overflow Elevation	Computed in Appendix B	Z_c	560.30 feet
4.10.3	Overflow Length	Computed in Appendix B	L	847.50 feet
4.10.4	Orifice Discharge Coefficient	Computed in Appendix B	$C_g(d/H_1)$	Equation B2

4.11	**Nonoverflow Section Overflow – Sta. 50+38 to 52+18**			
4.11.1	Discharge Coefficient	Computed in Appendix B	C_f	3.33
4.11.2	Overflow Elevation	Computed in Appendix B	Z_c	560.30 feet
4.11.3	Overflow Length	Computed in Appendix B	L	180 feet
4.11.4	Orifice Discharge Coefficient	Computed in Appendix B	$C_g(d/H_1)$	Equation B2
4.12	**Nonoverflow Section Overflow – Sta. 52+18 to 53+53**			
4.12.1	Discharge Coefficient	Computed in Appendix B	C_f	3.33
4.12.2	Overflow Elevation	Computed in Appendix B	Z_c	560.30 feet
4.12.3	Overflow Length	Computed in Appendix B	L	135 feet
4.12.4	Orifice Discharge Coefficient	Computed in Appendix B	$C_g(d/H_1)$	Equation B2
4.13	**Nonoverflow Section Overflow – Sta. 53+53 to 68+09.44**			
4.13.1	Discharge Coefficient	Computed in Appendix B	C_f	3.33
4.13.2	Overflow Elevation	Computed in Appendix B	Z_c	560.30 feet
4.13.3	Overflow Length	Computed in Appendix B	L	1070.94 feet
4.14	**Powerhouse – Section 1 – Control Building**			
4.14.1	Discharge Coefficient	Computed in Appendix B	C_f	2.65
4.14.2	Overflow Elevation	Computed in Appendix B	Z_c	569.05 feet
4.14.3	Overflow Length	Computed in Appendix B	L	48.00 feet
4.15	**Powerhouse – Section 2 – Remainder of Powerhouse**			
4.15.1	Discharge Coefficient	Computed in Appendix B	C_f	2.65
4.15.1	Overflow Elevation	Computed in Appendix B	Z_c	569.05 feet
4.15.1	Overflow Length	Computed in Appendix B	L	925.50 feet
4.16	**Roadway – Sta. 4+67 to 50+38**			
4.16.1	Discharge Coefficient	Computed in Appendix B	C_f	2.65
4.16.2	Overflow Elevation	Computed in Appendix B	Z_c	569.05 feet
4.16.3	Overflow Length	Computed in Appendix B	L	4571 feet
4.17	**Roadway – Sta. 50+38 to 51+73**			
4.17.1	Discharge Coefficient	Computed in Appendix B	C_f	2.65
4.17.2	Overflow Elevation	Computed in Appendix B	Z_c	569.65 feet
4.17.3	Overflow Length	Computed in Appendix B	L	135 feet
4.18	**Turbine Discharge**			
4.18.1	Maximum HW Elevation	Ref. 2.1, Section H-H		558.3 feet
4.18.2	Maximum TW Elevation	Refer to Section 3.6		514.8 feet
4.18.3	Minimum Gross Head	Ref. 2.2, page 39	H_g	38 feet
4.18.4	Maximum Sustainable Discharge	Ref. 2.2	Q_{Tmax}	117,440 cfs
4.19	**Tailwater Rating Curve**	Refer to Section 4.21	TW(Q)	Equation 4
4.20	**Upper Limit on Headwater Elevation for Rating**	Refer to Section 4.22	HW_{max}	570 feet

4.21 Tailwater Rating Curve

The tailwater rating curve used in this calculation is shown in Attachment 7. Attachment 8 lists points scaled from this plot and shows a polynomial fit to the result. The polynomial indicated in Attachment 8 and repeated below is used for the headwater rating curve calculations.

$$TW = -2x10^{-11}Q^4 + 6x10^{-8}Q^3 - 4x10^{-5}Q^2 + 0.0121Q + 507.09 \qquad \text{(Equation 4)}$$

in which Q = total discharge past the dam in cfs divided by 1000 ("1000 cfs").

Attachment 2 indicates tailwater effects are not significant until d/Hc (see definition sketch for spillway discharge, Figure A4, Appendix A) approaches a value of 0.6. Calculation of d/H_c during headwater rating confirms that tailwater effects can be neglected.

4.22 Upper Limit on Headwater Elevation included in Rating Curve

The headwater rating curve needs to include all headwater elevations that may occur during a PMF event. The value listed in the Reference 2.2 is 567.7 feet. However, the headwater at Wheeler Dam could be expected to rise to 570 feet (value from preliminary estimates).

4.23 Difference in 1912 Vertical Datum and 1929 Vertical Datum

According to TVA drawing 232-D-729 (Attachment B10), all elevations shown in the older drawings (232-D series) should be adjusted by 0.3' to convert from the 1912 vertical datum to the 1929 vertical datum. Elevations are taken from the Blue Book (Reference 2.2) or drawing 10W200 (Reference 2.1) whenever possible to avoid the conversion.

5. Special Requirements / Limiting Conditions

N/A

6. Calculations

The calculations consist of computing spillway and overflow discharges (from Equations 1 and 2) for a list of headwater elevations ranging from 541.3 feet up to 570 feet [4.18], the assumed PMF elevation. The headwater rating curve is a plot of headwater elevation versus total dam discharge.

Below an elevation of 541.3 feet, no discharge passes the dam. Beginning at 541.3 feet, the discharge passes through the spillway. Then beginning at elevation 550 feet, discharge also begins to pass through the turbines. Flows are calculated as outlined in sections 3.6 through 3.8.

After the headwater reaches an elevation of 556.3 feet, discharge continues to pass through the spillway, and then over various portions of the dam. At an elevation of 569.05 feet, discharge passes over various portions of the roadway, and then over the powerhouse. Total discharge, given in "1000 cfs," is the sum of all discharges in cfs past the dam divided by 1000.

Table 1 shows the spreadsheet calculations for the headwater rating curve (spreadsheet included as Attachment 8). The final result, the rating curve, is defined by the first two columns, HW vs. Total Discharge. The third column (TW) gives the tailwater elevation associated with the "Total Discharge" from the tailwater rating curve polynomial fit [4.21]. This is computed to verify that tailwater does not affect discharge.

Spillway discharge is computed in the sixth column. H_c and $C_f|C_g$ are the parameters used to determine the spillway discharge, $Q_f|Q_g$.. Free discharge occurs for elevations below 561.09 feet [4.3.4] and orifice discharge occurs for headwaters above this elevation. The transition point is indicated by a horizontal line. Above the transition line, the listed discharge coefficient is C_f [4.2.3] and below the transition line the listed discharge coefficient is C_g [4.3.5]. Column $Q_f|Q_g$ is the spillway discharge computed from Equation 1 for free discharge and from Equation 2 for orifice discharge. Cells with a zero indicate that the data was not applicable for the given headwater elevation.

Nonoverflow discharge is computed in the next 4 sections. d/H_1 and $C_f|C_g$ are the parameters used to determine the spillway discharge, $Q_f|Q_g$. Free discharge occurs for elevations below 564.76 feet for Sta. 4+67 to 50+38; 565.36 feet for Sta. 50+38 to 52+18; and 568.01 feet for Sta. 52+18 to 53+53. Orifice discharge occurs for headwaters above these elevations respectively. The transition point is indicated by a horizontal line. Above the transition line, the listed discharge coefficient is C_f and below the transition line the listed discharge coefficient is C_g. Column $Q_f|Q_g$ is the nonoverflow discharge computed from Equation 1 for free discharge and from Equation 2 for orifice discharge. Cells with a zero indicate that the data was not applicable for the given headwater elevation.

The column following the spillway discharge column shows "Sta," "C_f=," "Z_c=," and "L=" in three rows to indicate the meaning of the values included in those rows in the "Overflow Discharge" columns.

The next eleven columns are overflow discharges in cfs for overflow of the locks walls, auxiliary lock gate, main lock gate, closed trashway, trashway piers, powerhouse, roadway and turbines. The calculation method of each column has been covered previously.

TVA

Calculation No. CDQ000020080021	Rev: 0	Plant: GEN	Page: 19
Subject: Initial Dam Rating Curve, Wheeler		Prepared	JBM
		Checked	WBB

Spillway Parameters: L = 2400 feet; Z_c = 541.30 feet; G = 15.83 feet; H_{mp} = 7.88 feet

Nonoverflow Parameters, Station 4+67 to 50+38: Z_c = 560.30 feet; L = 847.5 feet; d = 4.46; H_{mp} = 4.00; Avg el. Top of Rdwy= 568.3 feet

Nonoverflow Parameters, Station 50+38 to 52+18: Z_c = 560.30 feet; L = 180 feet; d = 5.52; H_{mp} = 4.53; Avg el. Top of Rdwy= 569.37 feet

Nonoverflow Parameters, Station 52+18 to 53+53: Z_c = 560.30 feet; L = 135 feet; d = 8.78; H_{mp} = 6.16; Avg el. Top of Rdwy= 572.62 feet

HW	Q Total Discharge 1000 cfs	TW feet	Spillway H_c feet	Spillway C_f | C_g	Spillway Q_f | Q_g cfs	Nonoverflow Section (4+67 to 50+38) H_c feet	d/H_1 feet	C_f | C_g	Q_f | Q_g cfs	Nonoverflow Section (50+38 to 52+18) d/H_1 feet	C_f | C_g	Q_f | Q_g cfs	Nonoverflow Section (52+18 to 53+53) d/H_1 feet	C_f | C_g	Q_f | Q_g cfs
541.3	0.00	507.09	0.0	2.81	0	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
541.5	0.61	507.10	0.2	2.84	610	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
542	4.11	507.14	0.7	2.92	4,110	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
544	33.79	507.46	2.7	3.17	33,793	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
546	81.61	507.84	4.7	3.34	81,614	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
548	143.83	508.17	6.7	3.46	143,833	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
550	336.67	508.66	8.7	3.56	219,042	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
551	379.07	508.78	9.7	3.61	261,448	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
552	424.71	508.96	10.7	3.66	307,087	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
553	473.58	509.22	11.7	3.71	355,959	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
554	525.61	509.59	12.7	3.76	407,988	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
555	580.59	510.10	13.7	3.80	462,970	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
556	638.14	510.80	14.7	3.85	520,511	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
557	697.74	511.70	15.7	3.88	579,970	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
558	758.56	512.82	16.7	3.91	640,383	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
559	820.59	514.17	17.7	3.93	701,740	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
560	766.49	512.98	18.7	3.94	764,270	0.0	0.00	3.33	0	0.00	3.33	0	0.00	3.33	0
561	836.67	514.55	19.7	3.95	828,796	0.7	6.37	3.33	1,653	7.89	3.33	351	12.54	3.33	263
561.09	843.59	514.72	19.79	3.95	834,701	0.8	5.64	3.33	1,982	6.99	3.33	421	11.11	3.33	316
562	844.92	514.76	20.7	0.75	823,067	1.7	2.62	3.33	6,255	3.25	3.33	1,329	5.16	3.33	996
563	870.24	515.40	21.7	0.73	829,626	2.7	1.65	3.33	12,521	2.05	3.33	2,659	3.25	3.33	1,994
564	914.05	516.59	22.7	0.73	850,897	3.7	1.20	3.33	20,086	1.49	3.33	4,266	2.37	3.33	3,199
565	953.78	517.75	23.7	0.72	877,919	4.7	0.95	0.62	15,715	1.18	3.33	6,108	1.87	3.33	4,581
566	1004.17	519.32	24.7	0.72	902,737	5.7	0.78	0.64	25,187	0.97	0.62	5,321	1.54	3.33	6,118
567	1057.06	521.08	25.7	0.72	927,895	6.7	0.67	0.65	32,359	0.82	0.63	7,431	1.31	3.33	7,796
568	1109.58	522.92	26.7	0.72	952,249	7.7	0.58	0.66	38,414	0.72	0.64	9,144	1.14	3.33	9,605
569	1162.10	524.82	27.7	0.72	975,860	8.7	0.51	0.67	43,759	0.63	0.65	10,631	1.01	3.33	11,536
570	1226.03	527.18	28.7	0.72	998,782	9.7	0.46	0.67	48,596	0.57	0.66	11,964	0.90	0.62	11,167

Overflow Discharge, Q_f in cfs

HW	Non Overflow Section	Lock Walls	Lock Walls	Aux. Lock Gate	Main Lock Gate	Closed Trash way	Trashway Piers	Power house	Power house	Roadway	Roadway	Turbine Flow
Sta.	53+53 to 68+09.44	Section 1	Section 2					Section 1	Section 2	4+67 to 50+38	50+38 to 51+73	
C_f =	3.33	2.65	2.65	3.33	2.95	3.33	3.33	2.65	2.65	2.65	2:65	
Z_c =	560.3	566.72	562.30	558.30	560.58	556.30	567.51	569.05	569.05	569.05	569.65	feet
L =	1070.94	172.92	18.76	60.08	110.08	75	20	48.00	925.50	4571	135	feet
541.3	0	0	0	0	0	0	0	0	0	0	0	0
541.5	0	0	0	0	0	0	0	0	0	0	0	0
542	0	0	0	0	0	0	0	0	0	0	0	0
544	0	0	0	0	0	0	0	0	0	0	0	0
546	0	0	0	0	0	0	0	0	0	0	0	0
548	0	0	0	0	0	0	0	0	0	0	0	0
550	0	0	0	0	0	0	0	0	0	0	0	117,625
551	0	0	0	0	0	0	0	0	0	0	0	117,625
552	0	0	0	0	0	0	0	0	0	0	0	117,625
553	0	0	0	0	0	0	0	0	0	0	0	117,625
554	0	0	0	0	0	0	0	0	0	0	0	117,625
555	0	0	0	0	0	0	0	0	0	0	0	117,625
556	0	0	0	0	0	0	0	0	0	0	0	117,625
557	0	0	0	0	0	146	0	0	0	0	0	117,625
558	0	0	0	0	0	554	0	0	0	0	0	117,625
559	0	0	0	117	0	1,108	0	0	0	0	0	117,625
560	0	0	0	443	0	1,777	0	0	0	0	0	0
561	2,089	0	0	888	88	2,545	0	0	0	0	0	0
561.09	2,504	0	0	932	118	2,618	0	0	0	0	0	0
562	7,905	0	0	1,424	549	3,399	0	0	0	0	0	0
563	15,822	0	29	2,039	1,223	4,331	0	0	0	0	0	0
564	25,381	0	110	2,723	2,054	5,336	0	0	0	0	0	0
565	36,338	0	221	3,470	3,018	6,409	0	0	0	0	0	0
566	48,531	0	354	4,275	4,098	7,545	0	0	0	0	0	0
567	61,847	68	507	5,134	5,282	8,741	0	0	0	0	0	0
568	76,198	664	677	6,044	6,564	9,995	23	0	0	0	0	0
569	91,514	1,578	862	7,002	7,934	11,303	121	0	0	0	0	0
570	107,738	2,722	1,062	8,007	9,389	12,664	262	118	2,271	11,216	74	0

Table 1 – Headwater Rating Curve Calculations for Wheeler Dam

7. Results/Conclusions

For convenience, the headwater rating results as shown in Table 2, separate from the calculation details provided above, are tabulated as total discharge in cfs versus headwater elevation in feet. The headwater rating curve is plotted in Figure 2.

In addition to the results shown below, a conclusion drawn from the calculation is that tailwater does not impact the calculation. Therefore, the Wheeler dam rating curve is not influenced by the tailwater at Wheeler created by Wilson Dam (the downstream dam).

The final dam rating curve will be developed in the SOCH PMF analysis calculation at a later date.

HW	Q Total Discharge 1000 cfs
541.3	0.00
541.5	0.61
542	4.11
544	33.79
546	81.61
548	143.83
550	336.67
551	379.07
552	424.71
553	473.58
554	525.61
555	580.59
556	638.14
557	697.74
558	758.56
559	820.59
560	766.49
561	836.67
561.09	843.59
562	844.92
563	870.24
564	914.05
565	953.78
566	1004.17
567	1057.06
568	1109.58
569	1162.10
570	1226.03

Table 2 – Headwater Rating Results

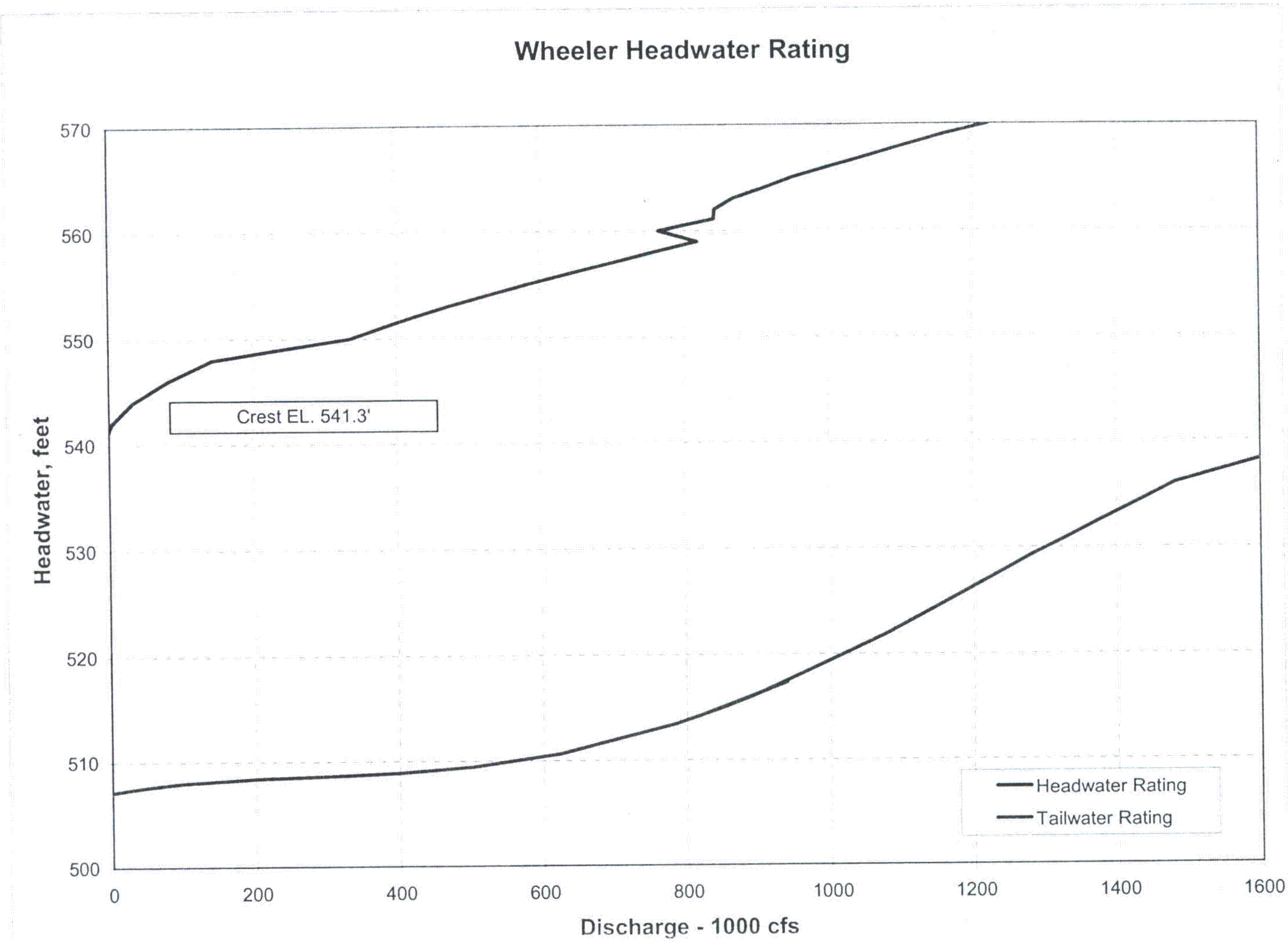

Figure 2 – Headwater Rating Curve

Appendix A: Spillway Discharge Coefficients for Wheeler Dam

TVA has model test data (Ref. A2) describing the relationships between discharge, headwater, tailwater, and gate opening for most of its spillways. These data are used in the headwater rating curve calculations. Use of reference book discharge coefficients for standard crests would result in inferior results because TVA's spillway crests are not standard.

Wheeler Dam has sixty spillway bays, each controlled by a radial (tainter) gate as illustrated in Reference A4. For headwater rating curve calculations, the gates are assumed to be open to their maximum opening position as specified in the Spillway Gate Arrangements table in Reference A1 and included as Attachment 6. As shown in this table, all sixty gates are set to their maximum opening position, indicator reading "UP," for gate arrangement number 120. Data were collected for three different maximum gate openings raised above the water surface. Data were not collected for gate openings above 15 feet when the headwater elevation is above the bottom of the open gate.

Test data summarized in Reference A2 involve a compilation of data from Apalachia, Boone, Fort Patrick Henry, Hales Bar, Hiwassee, Watts Bar and Wheeler model tests. These data, which define both free and orifice discharge coefficients with respect to gate opening, headwater elevation and crest shape, are used here to determine the free discharge and orifice discharge parameters for the Wheeler spillway gates open to 15.78 feet. Justification of the individual values will be included in each section.

A.1 References

A1. "Wheeler Dam Spillway Discharge Tables," River Systems Operations & Environment, Tennessee Valley Authority, 2004 (Attachment 6).

A2. "Tainter Gate Rating Data Determined from Eight TVA Model Studies," Division of Water Control Planning, Tennessee Valley Authority, 1962 (Attachment 4).

A3. "Hydraulic Design Criteria," Hydraulic Design Chart 711 (HDC 711), USACE (U. S. Army Engineer Waterways Experiment Station), Eighteenth issue, Vicksburg, MS, 1988 (Attachment 2).

A4. TVA drawing no: 232-D-723 (Attachment A2).

A5. TVA drawing no: 232-D-455 (Attachment A3).

A6. "Hydraulic Design Criteria," Hydraulic Design Chart 311 (HDC 311), USACE (U. S. Army Engineer Waterways Experiment Station), Eighteenth issue, Vicksburg, MS, 1988 (Attachment A4).

A7. TVA drawing no. 232-D-728 (Attachment A5)

A.2 Discharge Equations

Figure A3 is a definition sketch for flow over the Wheeler Dam spillway. Free discharge occurs for headwater elevations below the elevation at which the overflowing nappe first touches the bottom lip of the gate, or $H_c \leq H_{Lmin}$, and is computed using a weir equation (e.g., Reference 2.6):

$$Q_f = C_f L H_c^{1.5}$$ (Equation A1)

in which
Q_f = free discharge (cfs)
C_f = free discharge coefficient (varies with H_c)
L = length of overflowing section (ft)
H_c = head on crest (ft) = HW - Z_c
HW = headwater elevation (ft)
Z_c = top, or crest, elevation of overflowing section (ft)

This equation need not be modified to account for tailwater submergence.

For headwater elevations above the elevation at which the nappe touches the gate lip, or $H_c > H_{Lmin}$, orifice flow occurs and is computed from (e.g., Reference 2.6)

$$Q_g = C_g G L \sqrt{2g\,(H_c - H_{mp})}$$ (Equation A2)

in which
Q_g = orifice discharge (cfs)
C_g = orifice discharge coefficient (varies with gate opening and H_c)
G = effective gate opening (ft)
g = acceleration of gravity (32.2 ft/s^2 – common knowledge)
H_{mp} = vertical distance between the mid-point of V and the headwater elevation

This equation need not be modified to account for tailwater submergence.

A.3 Model Test Data

The 1:34.35 scale Wheeler model test data (Reference A2) are used to determine

- C_f (H_c)
- H_{Lmin} and C_g (H_c) for V = 15.78 ft.

The model test data, scaled to prototype values, for both orifice and free discharge, are plotted and tabulated in Attachment 4. These data are used in Sections A.5 through A.7 to estimate H_{Lmin} and C_g (H_c) for V=15.78 feet and to establish a curve fit for C_f (H_c).

A.4 Geometry

To calculate the maximum gate opening V under PMF conditions, the elevation of the gate lip was determined. A summary of the calculations is shown below, and parameters are defined in Figures A2 through A6. From Reference A4:

- R = 17.5 feet
- Z_c = 541.3 feet
- Z_{tr} = 547.47 feet
- Z_o = 541.3' + 15' = 556.3 feet
- Z_1 = 547.47' – 541.3' = 6.17 feet

- $Z_2 = 556.3' - 547.47' = 8.83$ feet
- a = 18" + 3" = 21 inches (Reference A7)

Angle θ:

$$\theta = \sin^{-1}\left(\frac{Z_2}{R}\right) + \sin^{-1}\left(\frac{Z_1}{R}\right)$$

$$\theta = \sin^{-1}\left(\frac{8.83'}{17.5'}\right) + \sin^{-1}\left(\frac{6.17'}{17.5'}\right) = \mathbf{50.9476°}$$

Angle Φ:

$$\phi = \sin^{-1}\left(\frac{a}{R}\right)$$

$$\phi = \sin^{-1}\left(\frac{21''}{17.5'}\right) = \mathbf{5.74°}$$

Angle α:

$$\alpha = 90° - \theta - \Phi$$

$$\alpha = 90° - 50.95° - 5.74° = \mathbf{33.31°}$$

Gate lip y-coordinate y_l

$$y_l = R \sin(\alpha)$$

$$y_l = 17.5' \sin(33.31°) = \mathbf{9.61\ feet}$$

Gate lip x-coordinate:

$$x_l = \sqrt{R^2 + y_l^{\,2}}$$

$$x_l = \sqrt{(17.5')^2 + (9.61)^2} = 14.63\,feet$$

Gate Opening V:

$$V = Z_{tr} - Z_c + y_l$$

$$V = 547.47' - 541.3' + 9.61' = \mathbf{15.78\ feet}$$

Parameters G, H_{mp}, and Z_o (gate overflow elevation) are computed from crest and gate geometry as described in Figure A3. Table A1 gives the values of these parameters for V = 0.98, 1.98, 3, 4, 7, 10 and 15.78 feet.

Table A1 – Geometric Parameters for Relevant Gate Openings

V, feet	G, feet	H_{mp}, feet	Z_o, feet	β, deg.
0	0.000	0.000	556.30	69.35
0.98	0.988	0.486	557.18	73.77
1.98	2.005	0.978	558.03	77.89
3	3.042	1.480	558.84	81.81
4	4.055	1.975	559.59	85.41
7	7.056	3.475	561.57	95.21
10	10.050	4.975	563.14	102.08
15.78	15.828	7.878	564.88	120.16

As an example, the procedure for computing the geometric parameters for V = 15.78 feet is given here.

Referring to Figure A3:

Overflow Elevation Z_o:

$$Z_o = Z_{tr} + R \sin(\theta + \alpha)$$

$$Z_o = 547.47' + 17.5' \sin(50.9476° + 33.31°) = 564.88 \text{ feet}$$

To get effective gate opening, G, equations for x_{sn} and y_{sn} must be determined. However, since no equation was given in the TVA drawings, spillway equations for the sections upstream and downstream of the crest were created in conjunction with Reference A4 and A5. The equations were used to determine x_{sn} and y_{sn} values, where x_{sn} and y_{sn} are points on the spillway. The values found are shown in Table A2.

Upstream of crest:

$R^2 = (x_s - h)^2 + (y_s - k)^2$

$(6.5')^2 = (x_s - 0)^2 + (y_s - (-6.5'))^2$

$42.25\ ft^2 - x^2 = (y_s + 6.5')^2$

$$\sqrt{42.25ft^2 - x_s^2} = y_s + 6.5'$$

$$\sqrt{42.25ft^2 - x_s^2} - 6.5' = y_s$$

Where $-5.1468' \le x_s \le 0'$

$y_s = 6.17' - y_{sn}$

$x_s = 16.375' - x_{sn}$

Therefore $16.375' \le x_{sn} \le 21.522'$

$$\sqrt{42.25ft^2 - (16.375' - x_{sn})^2} - 6.5' = 6.17' - y_{sn}$$

$$f(x_{sn}) = y_{sn} = -\sqrt{42.25ft^2 - (16.375' - x_{sn})^2} + 12.67'$$

$$\frac{dy_{sn}}{dx} = \frac{x_{sn} - 16.375'}{\sqrt{-x_{sn}^2 + (32.75')x_{sn} - 225.891'}}$$

Solve for x_{sn} at $V = 7'$:

$$0 = x_{sn} - x_l + \left[f(x_{sn}) - y_l\right]\left[\frac{df(x_{sn})}{dx}\right]$$

$$0 = x_{sn} - 17.480' + \left[-\sqrt{42.25ft^2 - (16.375' - x_{sn})^2} + 12.67' - (-0.83')\right]\left[\frac{x_{sn} - 16.375'}{\sqrt{-(16.375' - x_{sn})^2 + (32.75')x_{sn} - 225.891'}}\right]$$

x_{sn} = **17.173 feet**

$$y_{sn} = -\sqrt{42.25ft^2 - (16.375' - 17.173')^2} + 12.67' = \mathbf{6.219\ feet}$$

x_s and y_s values for openings V = 3, 4 and 7 were found using the upstream equation, and values for V = 0, 0.98, 1.98 and 10 were found using an iteration process.

Downstream of crest:

$R^2 = (x_s - h)^2 + (y_s - k)^2$

$(16')^2 = (x_s - 0)^2 + (y_s - (-16')^2$

$256\ ft^2 - x_s^2 = (y_s + 16')^2$

$$\sqrt{256ft^2 - x_s^2} = y_s + 16'$$

$$\sqrt{256ft^2 - x_s^2} - 16' = y_s$$

Where $0' \le x_s \le 7.40'$

$y_s = 6.17' - y_{sn}$
$x_s = 16.375' - x_{sn}$

Therefore $8.975' \le x_{sn} \le 16.375'$

$$\sqrt{256ft^2 - (16.375' - x_{sn})^2} - 16' = 6.17' - y_{sn}$$

$$f(x_{sn}) = y_{sn} = -\sqrt{256ft^2 - (16.375' - x_{sn})^2} + 22.17'$$

$$\frac{dy_{sn}}{dx} = \frac{x_{sn} - 16.375'}{\sqrt{-x_{sn}^2 + (32.75')x_{sn} - 12.1406'}}$$

Solve for x_{sn} at $V = 15.78$ feet:

$$0 = x_{sn} - x_l + \left[f(x_{sn}) - y_l\right]\left[\frac{df(x_{sn})}{dx}\right]$$

$$0 = x_{sn} - 14.6252' + \left[-\sqrt{256ft^2 - (16.375' - x_{sn})^2} + 22.17' - (-9.61')\right]\left[\frac{x_{sn} - 16.375'}{\sqrt{-x_{sn}^2 + (32.75')x_{sn} - 12.1406}}\right]$$

x_{sn} = **15.495 feet**

$$y_{sn} = -\sqrt{256ft^2 - (16.375' - 15.431')^2} + 22.17' = \mathbf{6.194\ feet}$$

The downstream equation is only used for V = 15.78 feet. Points on the spillway for the other gate openings are on the upstream side of the crest.

Table A2 – Spillway Values for Each Gate Opening

V, feet	x_{sn}, feet	y_{sn}, feet
0	16.375	6.170
0.98	16.695	6.178
1.98	16.930	6.194
3	17.091	6.210
4	17.186	6.221
7	17.173	6.219
10	17.174	6.219
12	16.450	6.170
14	15.989	6.175
15.78	15.495	6.194

- x_{sn} = 15.495 feet
- y_{sn} = 6.194 feet

Therefore $G = \sqrt{(14.63'-15.495')^2 + (6.194'-(-9.61'))^2} = 15.83\,feet$

$$H_{mp} = 15.78' - \frac{(6.194'-(-9.61'))}{2} = 7.88\,feet$$

$$\beta = \frac{\Pi}{2} - \tan^{-1}\left(\frac{-9.61'}{14.63'}\right) - \tan^{-1}\left(\frac{15.495'-14.63'}{6.194'-(-9.61')}\right) = 120.16^{\circ}$$

A.5 Determination of H_{Lmin} (V)

Attachment 8 shows a linear fit for H_{Lmin} versus V from the model test data (Reference A2). A value of H_{Lmin} for V=15.78 feet is established by using the line to extrapolate the data. The following is used for the dam rating curve calculations:

$H_{L\,min}$ = 1.238V + 0.2495
Therefore,
H_{Lmin} = 19.79 feet for V = 15.78 feet.

A.6 Determination of C_f (H_c)

Attachment 8 shows a polynomial curve fit to the model test data for free discharge. The polynomial indicated is used to calculate the free discharge coefficient for flow over the crest for the dam rating curve calculations:

$C_f = -0.0000326H_c^4 + 0.0013279H_c^3 - 0.0199504H_c^2 + 0.1807152H_c + 2.8067868$ (Equation A3)

in which
C_f = free discharge coefficient
H_c = head on crest (ft)

Above H_c = 17.45 feet, Equation A3 crests. As the polynomial curves downward, C_f decreases in value with H_c increasing. To counter this affect, at H_c = 17.45 feet, a linear extrapolation is taken:

$C_f = 0.0114H_c + 3.7233$ (Equation A4)

A.7 Determination of C_g (H_c) for V = 15.78 feet

Attachment 8 shows the calculations and results for extrapolating C_g (H_c) for V=15.78 feet from the model data for other gate openings. The first column in Attachment 8 indicates the data for which H_c=H_{Lmin}, at which H_c is just high enough to touch the bottom of the gate. The discharge indicated for V=15.78 feet at H_c=H_{Lmin} is the free discharge computed using C_f (H_c) from Equation A3. The first three numerical columns list the model data (scaled to prototype dimensions) for V= 3, 4, 7 and 10 feet as listed in Reference A2. The rows that do not include values of discharge, Q, were added to extrapolate the data. The next two columns after the model data list prototype geometrical parameters. The last numerical column lists the C_g values computed from the data. Values that were "estimated" for extrapolation purposes are labeled as such to the right of the C_g column.

Attachment 8 shows C_g plotted against H_c for all gate openings. The model data points are shown along with lines drawn through the data and extended to H_c = 19.79 feet. The estimated curve for V = 15.78 feet starts with the value for H_c = H_{Lmin} and runs approximately parallel to the curve for V = 10 feet. Given the absence of data, this extrapolated line segment fit for

BWSC Barge Waggoner Sumner & Cannon, Inc.

Project: Wheeler Dam
Description: Spillway Gate Geometry
Project No. ______ Sheet No. ______ of ______
Designer: JBM Date: 7/7/09
Checker: ______ Date: ______

Variables:

V = vertical distance between the bottom of the open gate and the crest
z_c = crest elevation
z_{tr} = trunnion elevation
z_o = overflow elevation
R = radius of the tainter gate
G = effective gate opening
H_{mp} = vertical distance between mid-point of G and the headwater elevation
β = angle formed by the tangent to the gate lip and the tangent to the crest curve at the nearest point of the curve
α = angle formed by the trunnion and the bottom of the gate
θ = angle of the sector of a circle formed by two lines connecting the trunnion axis to the bottom and top of the gate
ϕ = angle formed by a vertical line and the line connecting the trunnion to the top of the gate

x, y = coordinates relative to trunnion axis
x_s, y_s = coordinates of spillway surface as defined by $y_s = f(x_s)$
x_ℓ, y_ℓ = coordinates of the gate lip relative to the trunnion axis

NOTE: for all coordinates, y is positive downward and coordinates are relative to trunnion axis

x_o, y_o = coordinates of overflow elevation

a = horizontal distance from trunnion to top of the gate in maximum open position.

Figure A2 – Variables for Spillway Gate Geometry

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Description: Spillway Gate Geometry
Project No. ______ Sheet No. ______ of ______
Designer: JBM Date: 7/7/09
Checker: ______ Date: ______

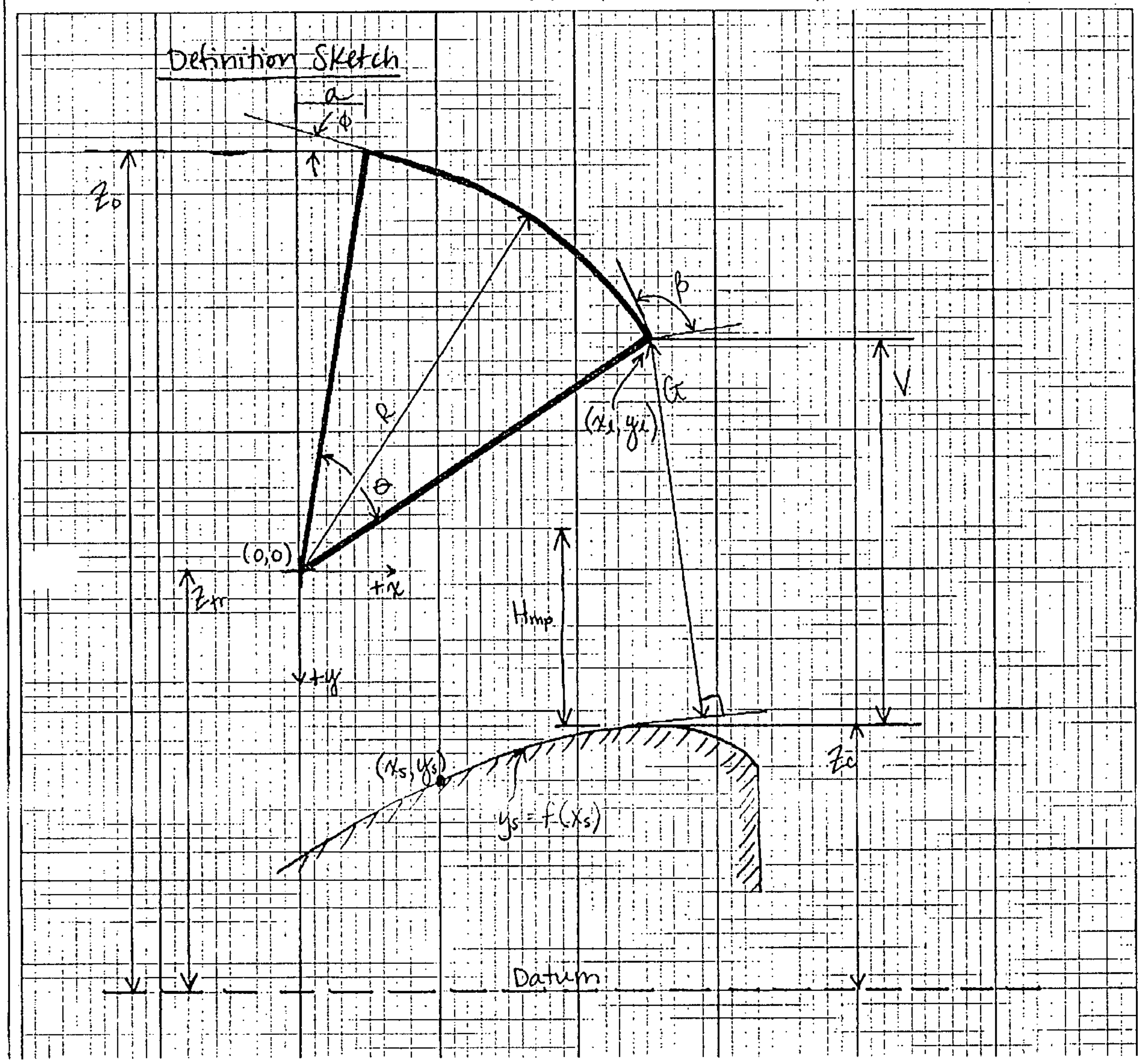

Figure A3 – Definition Sketch for Spillway Gate Geometry

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Project: Wheeler Dam
Description: Spillway Gate Geometry
Project No. ______ Sheet No. ______ of ______
Designer: JBM Date: 8/3/09
Checker: ______ Date: ______

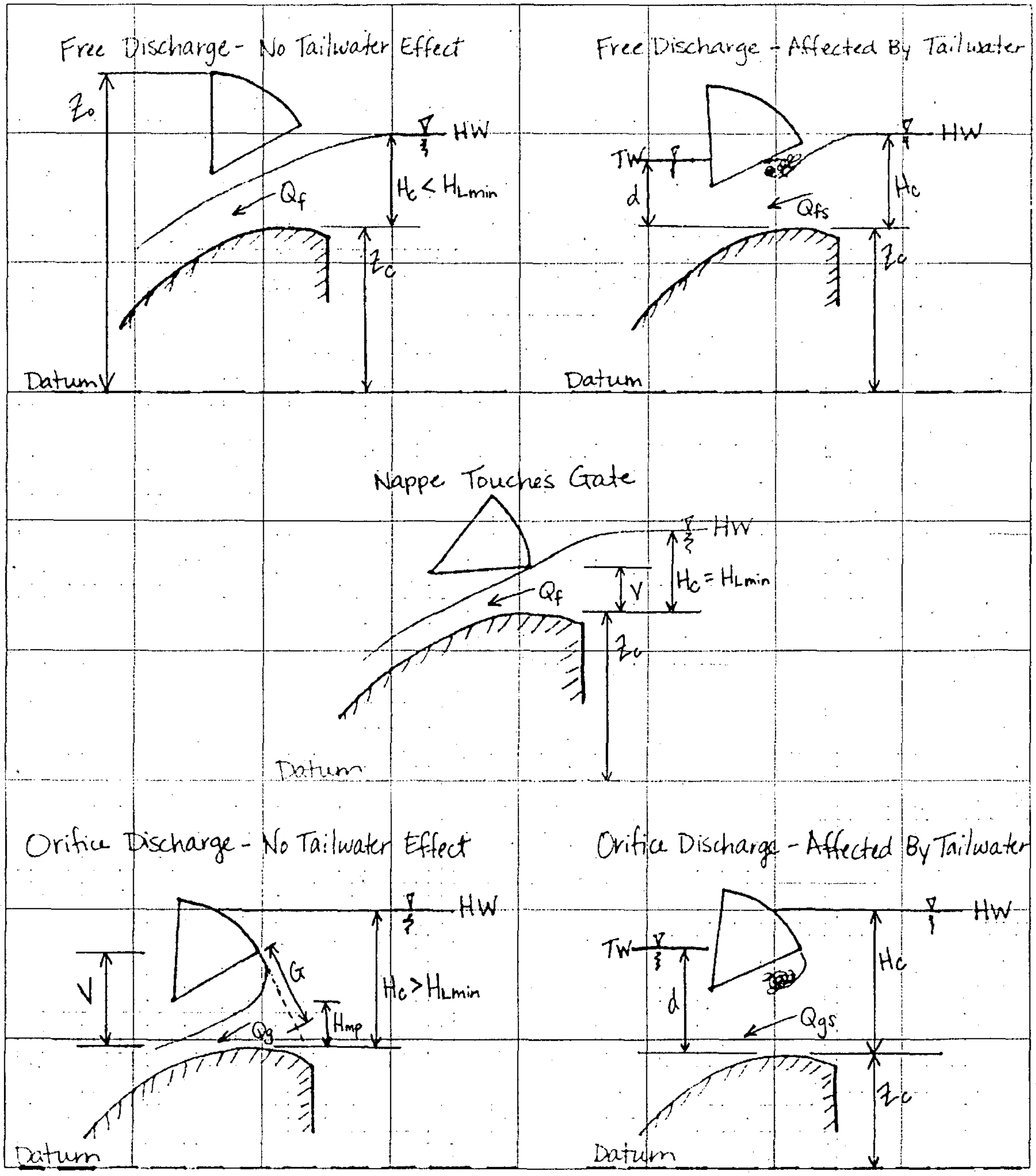

Figure A4 – Definition Sketch for Spillway Discharge

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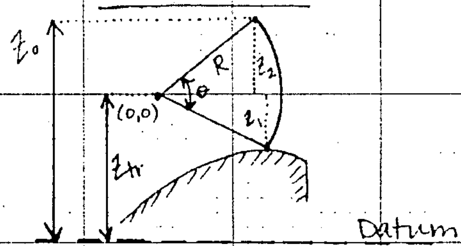
Project: Wheeler Dam
Description: Spillway Gate Geometry
Project No. ______ Sheet No. ______ of ______
Designer: JBM Date: 7/7/09
Checker: ______ Date: ______

Closed Gate

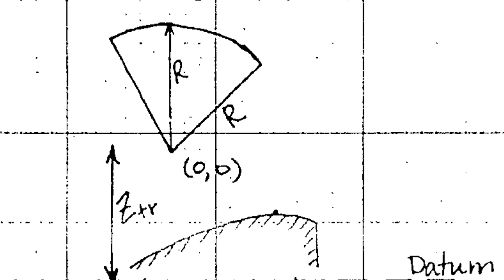


$$\theta = \sin^{-1}\left(\frac{z_2}{R}\right) + \sin^{-1}\left(\frac{z_1}{R}\right)$$

R, z_1 and z_2 are determined from drawings.

Open Gate

when upper lip of gate is downstream of trunnion



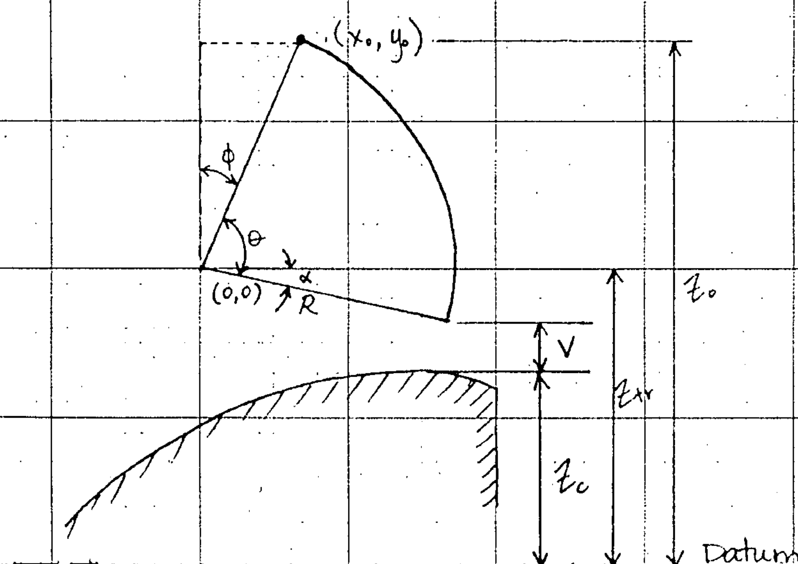
$$z_0 = z_{tr} + R$$

Figure A5 – Spillway Gate Geometry

BWSC — BARGE WAGGONER SUMNER & CANNON, INC.

Project: Wheeler Dam
Description: Spillway Gate Geometry
Project No. ______ Sheet No. ______ of ______
Designer: JBM Date: 7/7/09
Checker: ______ Date: ______

Gate Not Fully Open



$$\alpha = \tan^{-1}\left(\frac{Z_{tr} - (Z_c + V)}{\sqrt{R^2 - (Z_{tr} - Z_c - V)^2}}\right)$$

$$Z_o = Z_{tr} + R\sin(\theta - \alpha)$$

$$\phi = \tan^{-1}\left(\frac{x_o}{y_o}\right) \quad \text{where} \quad x_o = R\cos(\theta - \alpha), \quad y_o = Z_o - Z_{tr}$$

Figure A6 – Spillway Gate Geometry

Appendix B: Overflow Parameters for Wheeler Dam

Overflow parameters for each portion of the Wheeler Dam can be found in the following calculations.

B.1 References

B1. "Rating Curves for Flow over Drum Gates," Joseph N. Bradley, Paper No. 2677, Transactions of the American Society of Civil Engineers, Vol. 119, p. 403 – 433, 1954 (Attachment B11).
B2. "Hydraulic Design Criteria," Design Chart 711, USACE (U. S. Army Engineer Waterways Experiment Station), Eighteenth issue, Vicksburg, MS, 1988 (Attachment 2).
B3. TVA Water Control Project Manual (Blue Book) for Wheeler Dam, TVA River Systems Operations, October 1999 (Attachment 5).
B4. TVA drawing no: 10W200 R0 (Attachment 1).
B5. TVA drawing no: 232-D-2111 (Attachment B12).
B6. TVA drawing no: 232-D-692 (Attachment B8).
B7. TVA drawing no: 51N4200 R3 (Attachment B2).
B8. TVA drawing no: 64N201 R2 (Attachment B6).
B9. TVA drawing no: 61N250 R7 (Attachment B3).
B10. TVA drawing no: 61N501 R3 (Attachment B4).
B11. TVA drawing no: 232-D-729 R4 (Attachment B10).
B12. TVA drawing no: 232-D-721 R3 (Attachment B9).
B13. TVA drawing no: 232-D-917 (Attachment B13).
B14. TVA drawing no: 232-D-452 (Attachment B7).
B15. TVA drawing no: 61N506 R2 (Attachment B5).
B16. TVA drawing no: 02-L3-20-2 R7 (Attachment B1).
B17. "Water Measurement Manual," United States Department of the Interior, Bureau of Reclamation, Denver, CO, 1967.
B18. TVA drawing no: 64N202, R2 (Attachment B14).
B19. TVA drawing no: 232-D-817 (Attachment B15).
B20. TVA drawing no: 232-D-540 (Attachment B16).
B21. TVA drawing no: 232-D-2721 (Attachment B17).

B.2 Closed Trashway Gates Overflow

B = 2.5' (Reference B7)
Zc = 556.3' (Reference B7)
L = 2 x 37.5' = 75' (Reference B7)

$$0 \le \frac{H}{B} \le \frac{570' - 556.3'}{2.5'} = 5.48$$

Therefore, this portion behaves as a sharp-crested weir. Use a standard value of C_f = 3.33 (Reference B17).

B.3 Trashway Piers Overflow

B = 8" (Reference B7)
Zc = 567.51' (Reference B7)
L = 2 x 10' = 20' (Reference B7)

$$0 \le \frac{H}{B} \le \frac{570' - 567.51'}{8''} = 3.735$$

Therefore, this portion behaves as a sharp-crested weir. Use a standard value of C_f = 3.33 (Reference B17).

B.4.1 Nonoverflow Section Overflow

B = 18" (Reference B14)
Zc = 560.3' (Reference B3)

Section 1 – Station 4+67 to 50+38 (beginning of nonoverflow sections to PVC)
L = 53' + 36.75' + 20.25' + 380' + 357.5' = 847.5' (from Reference B4 and Reference B13 – See Figures B1 and B2)
(Includes part of nonoverflow dam, structure between Units 8 & 9, and loading platform)

Section 2 – Station 50+38 to 52+18 (PVC to PVI)
L = 180' (Reference B13 – Figure B2)

Section 3 – Station 52+18 to 53+53 (PVI to elevation at which the bottom of the road is above PMF – 571.27')
L = 135' (Reference B3, Figure 5)

Section 4 – Station 53+53 to 68+09.44 (elevation at which the bottom of the road is above PMF – 571.27' to end of dam)
L = 1070.94' (Reference B3, Figure 5) (remaining portions of nonoverflow)

$$0 \le \frac{H}{B} \le \frac{570' - 560.3'}{18"} = 6.467$$

Therefore, these portions behave as a sharp-crested weir. Use a standard value of $C_f = 3.33$ (Reference B17). When roadway overtopping occurs, portions of the nonoverflow dam will then change to orifice flow. See the following section for discussions on the nonoverflow orifice discharge.

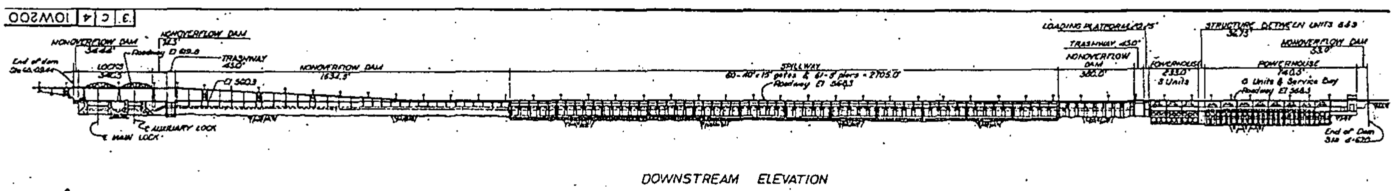


Figure B1 – Nonoverflow Sections

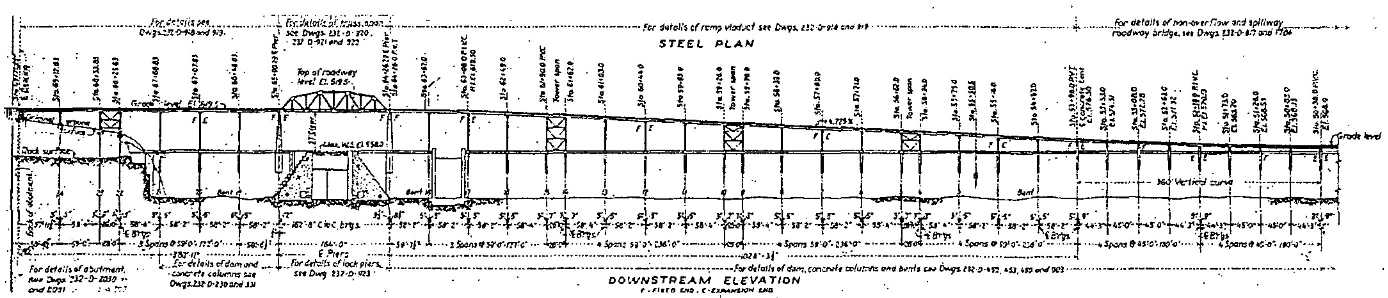


Figure B2 – Nonoverflow Sections

B.4.2 Nonoverflow Discharge Equations

For headwater elevations above the elevation at which the nappe touches the bottom of the roadway, orifice flow occurs and is computed from (e.g., Reference 2.6)

$$Q_g = C_g GL\sqrt{2g(H_c - H_{mp})} \qquad \text{(Equation B1)}$$

in which variables are defined as follows:
Q_g = orifice discharge (cfs)
C_g = orifice discharge coefficient (varies with gate opening and H_c)
G = effective gate opening (ft)
g = acceleration due to gravity (ft/s^2)
H_{mp} = vertical distance between the mid-point of G and the headwater elevation (ft)

Attachment 8 shows orifice flow calculations for various sections of the nonoverflow portions of the dam. Equation B2 is determined by calculating d and d/H_l. (e.g., Reference 2.9)

$$C_g = -0.106 * d/H_l + 0.72 \qquad \text{(Equation B2)}$$

in which variables are defined as follows:
H_l = HW - Z_c (ft)
d = distance between top of nonoverflow section and bottom of roadway (ft)
d/H_l = ratio of distance between crest and bottom of road to distance between headwater and crest (ft)

B.5 Lock Walls Overflow

Overflow from the narrow approach walls of the locks will be ignored. Use Figure B3 for the following dimensions:

Section 1
Zc = 566.72' (Reference B10)
L = 34' + 77.92' + 30.5'= 172.92'
B = 74.48' + 415' = 489.48'

$$0 \le \frac{H}{B} \le \frac{570' - 566.72'}{489.48'} = 0.0067$$

Therefore, using Reference B2, C_f = 2.65.

Section 2 – Sloping Portion of Lock Wall
Zc = 562.3' (Reference B4, Section J-J)
Use 1:0.72 slope to calculate length.

$$\frac{1}{0.72} = \frac{518.36' - 492.3'}{L}$$

(492.3' from Reference B15; slope 1:0.72 and 518.36' from Reference B10, Section D-D)

L = 18.76'
B = 74.48' + 415' = 489.48'

$$0 \le \frac{H}{B} \le \frac{570' - 562.3'}{489.48'} = 0.0157$$

Therefore, using Reference B2, C_f = 2.65.

B.6 Auxiliary Lock Gate Overflow

Use Figure B3 for the following dimensions:

B = 5' (Reference B16)
Zc = 558.3' (Reference B4)
L = 60.08' (Reference B4)

$$0 \le \frac{H}{B} \le \frac{570' - 558.3'}{5'} = 2.34$$

Therefore, this portion behaves as a sharp-crested weir. Use a standard value of $C_f = 3.33$ (Reference B17).

B.7 Main Lock Gate Overflow

B = 6.625' (Reference B8)
Zc = 560.58' (Reference B18)
L = 110.08' (Reference B4)

$$0 \le \frac{H}{B} \le \frac{570' - 560.58'}{6.625'} = 1.422$$

Therefore, using Reference B2, $2.65 \le C_f \le 3.24$. An average C_f value of 2.95 should be used.

B.8 Powerhouse Overflow

Section 1 – Control Building (Sta. 5+20 to 5+68)
B = 193.2' (Reference B5)
Zc = 569.05' (Reference B4)
L = 48' (Reference B20)

$$0 \le \frac{H}{B} \le \frac{570' - 569.05'}{193.2'} = 0.0049$$

Therefore, using Reference B2, $C_f = 2.65$

Section 2 – Remainder of Powerhouse (Sta. 5+68 to 12+60.5 and 12+97.25 to 15+30.25)
B = 65' (Reference B21)
Zc = 569.05' (Reference B4)
L = 233' + 740.5' – 48' = 925.5' (Reference B4)

$$0 \le \frac{H}{B} \le \frac{570' - 569.05'}{65'} = 0.015$$

Therefore, using Reference B2, $C_f = 2.65$

TVA

Calculation No. CDQ000020080021	Rev: 0	Plant: GEN	Page: B6
Subject: Initial Dam Rating Curve, Wheeler		Prepared	JBM
Appendix B		Checked	WBB

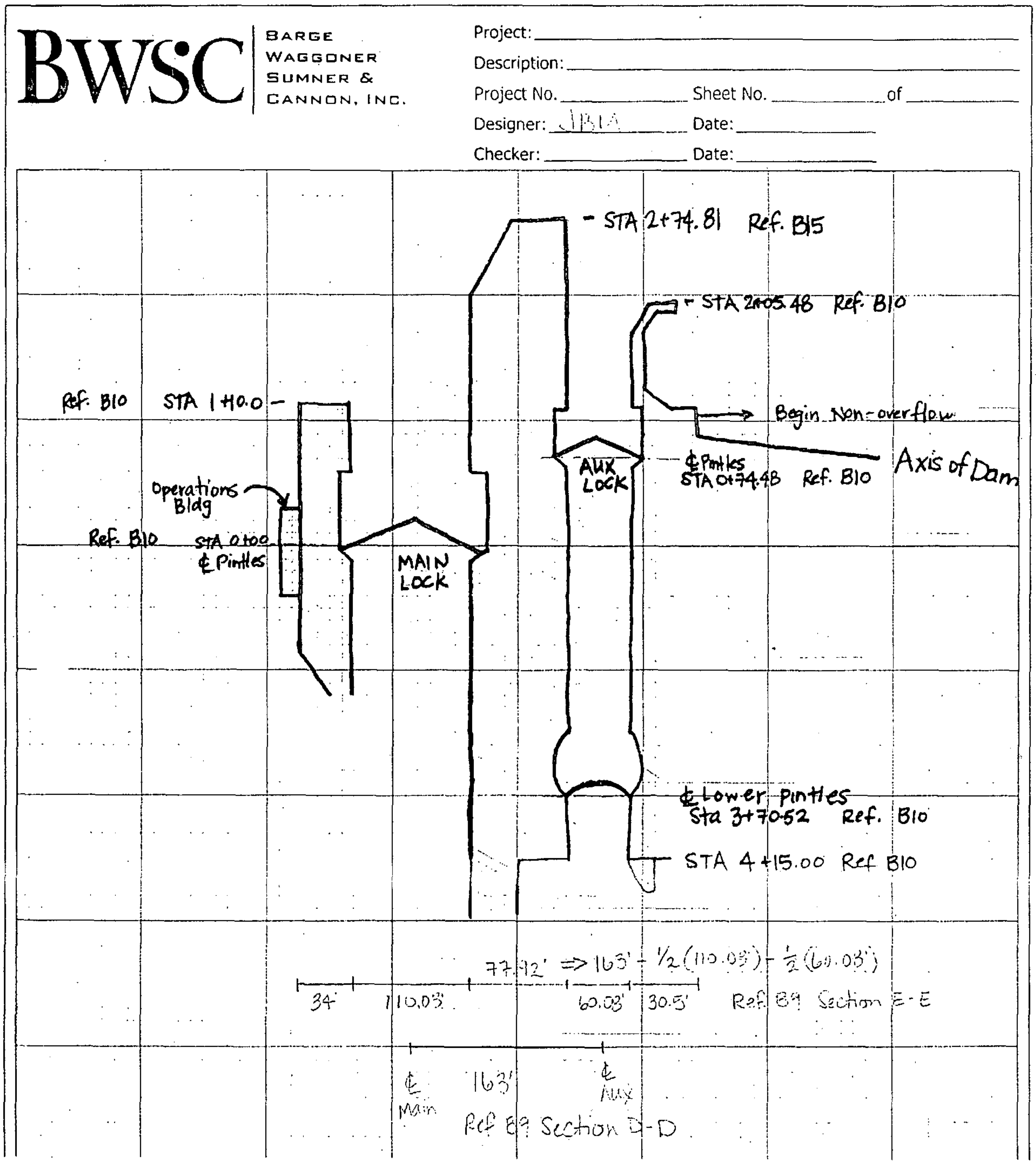


Figure B3 – Locks

Appendix C: Hydrostatic Loads on the Spillway Tainter Gates

The hydrostatic loads on the spillway tainter gates for Wheeler Dam can be found in the following calculations.

C.1 References

C1. Wheeler.xls – Hydrostatic Forces tab (Attachment 8).
C2. "Engineering Fluid Mechanics," Clayton T. Crowe, John Wiley & Sons, Inc. 8th ed, p. 53-55, 2005.
C3. TVA drawing no: 232-D-728 (Attachment A5).
C4. TVA Water Control Project Manual (Blue Book) for Wheeler Dam, TVA River Systems Operations, October 1999 Wheeler Blue Book (Attachment 5).

C.2 Calculations for Closed Gate when water level is at top of gate

Table C1 is a summary of known values. The values are computed in Appendix A. The parameters are defined in Figure C1.

Known Values	
Z_c	541.3 ft
Z_{tr}	547.47 ft
Z_o	556.3 ft
R	17.5 ft
L	40 ft

Table C1 – Known Values (References C3 and C4)

- $\alpha_1 = \sin^{-1}\left(\frac{Z_{tr} - Z_c}{R}\right)$

  $= \sin^{-1}\left(\frac{547.47' - 541.3'}{17.5'}\right)$

  = 20.64°

- $\alpha_2 = \sin^{-1}\left(\frac{Z_o - Z_{tr}}{R}\right)$

  $= \sin^{-1}\left(\frac{556.3' - 547.47'}{17.5'}\right)$

  = 30.30°

- $\theta = \alpha_1 + \alpha_2 =$ **50.95°**

- $A_{Projected} = L (Z_o - Z_c)$
  = 40' (556.3' – 541.3')
  = 600 sf

- $F_{Rx} = \gamma h_c A_{Projected}$ (Reference C2)
  = (62.4 pcf) ((0.5) (556.3' – 541.3')) (600 sf)
  = 280.80 kip

- $x_1 = R - \left(R * \cos\left(\sin^{-1}\left(\frac{(Z_o - Z_{tr})}{R} \right)\right)\right)$

  $= 17.5' - \left(17.5' * \cos\left(\sin^{-1}\left(\frac{(556.3' - 547.47')}{17.5'} \right)\right)\right)$

  = 2.39'

- $A_{Slice2} = \Pi R^2 (\alpha_2/360°)$
  $= \Pi * (17.5')^2 * (30.303° / 360°)$
  = 80.99 sf

- $F_{Ry} = \gamma Vol = \gamma L[(Z_0 - Z_{tr})x_1 - A_{Slice2} + 0.5(R - x_1)(Z_o - Z_{tr})]$ (Reference C2)
  = (62.4 pcf) (40')[(556.3' – 547.47')(2.39') - (80.99sf) + 0.5(17.5' – 2.39')(556.3' – 547.47')]
  = 17.06 kip

- $Z_1 = Z_o - \left(\frac{2}{3}(Z_o - Z_c) \right)$

  $= 556.3' - \left(\frac{2}{3}(556.3' - 541.3') \right)$

  = 546.30'

- $F_R = \sqrt{(280.80kip)^2 + (17.06kip)^2}$ (Reference C2)
  = 281.32 kip

Summary of Calculated Values			
α_1	20.64°	x_1	2.39 ft
α_2	30.30°	Z_1	546.30 ft
θ	50.95°	F_{Rx}	280.80 kip
$A_{Projected}$	600 sf	F_{Ry}	17.06 kip
A_{Slice2}	80.99 sf	F_R	281.32 kip

Table C2 – Summary of Calculated Values for Closed Gate at PMF

C.3 Calculations for Open Gate at PMF

Known values are computed in Appendix A. The parameters are defined in Figure C1.

- $Z_2 = V + Z_c$
  $= 15.78' + 541.3'$
  $= \mathbf{557.08'}$

- $$\alpha_3 = \sin^{-1}\left(\frac{Z_2 - Z_{tr}}{R}\right)$$
  $$= \sin^{-1}\left(\frac{557.08' - 547.47'}{17.5'}\right)$$
  $= \mathbf{33.31°}$

- $Z_o = Z_{tr} + R \sin(\theta + \alpha_3)$
  $= 547.47' + 17.5 \sin(50.9476° + 33.308°)$
  $= \mathbf{564.88'}$

- $A_{Projected} = L\,(Z_o - Z_2)$
  $= 40'\,(564.882' - 557.08')$
  $= \mathbf{312.09\ sf}$

- $$F_{Rx} = \gamma h_c A_{Projected} = \gamma\left(\frac{(HW_{Max} - Z_2) + (HW_{Max} - Z_o)}{2}\right) A_{Projected}$$
  $$= (62.4\,pcf)\left(\frac{(570' - 557.08') + (570' - 564.882')}{2}\right)(312.09\,sf)$$
  $= \mathbf{175.64\ kip}$

- $y_1 = HW_{Max} - Z_o$
  $= 570' - 564.88'$
  $= \mathbf{5.12'}$

- $x_2 = R \cos\alpha_3 - R\cos(\theta + \alpha_3)$
  $= 17.5' \cos(33.31°) - 17.5' \cos(50.9476° + 33.31°)$
  $= \mathbf{12.87'}$

- $A_{Slice3} = \Pi R^2 (\theta / 360°)$
  $= \Pi * (17.5')^2 * (50.9476° / 360°)$
  $= \mathbf{136.16\ sf}$

- $A_{Triangle} = 0.5*(2*R*\sin(\theta / 2))*(R*\cos(\theta / 2))$
  $= 0.5 * (2)(17.5')(\sin(50.9476° / 2))\,(17.5')(\cos(50.9476° / 2))$
  $= \mathbf{118.91\ sf}$

- $F_{Ry} = \gamma Vol = \gamma L\left[(y_1)(x_2) + (Z_o - Z_2)(x_2) - 0.5(x_2)(Z_o - Z_2) - A_{Slice3} + A_{triangle})\right]$

$= (62.4pcf)(40')[(5.12')(12.87') + (564.88'-557.08')(12.87') - 0.5(12.87')(564.08'-557.08') - 136.16sf + 118.91sf]$
$=$ **246.76 kip**

- $F_R = \sqrt{(246.76kip)^2 + (175.64kip)^2}$
  = **302.88 kip**

Summary of Calculated Values			
α_3	333.31°	$A_{triangle}$	118.91 ft
Z_2	557.08 ft	x_2	12.87 ft
Z_o	564.88 ft	F_{Rx}	175.64 kip
$A_{Projected}$	312.09 sf	F_{Ry}	246.76 kip
A_{Slice3}	136.16 sf	F_R	302.88 kip

Table C3 – Summary of Calculated Values for Open Gate at PMF

C.4 Conclusion

The resultant force on the closed gate when water is at the PMF level is 281.32 kip. The resultant force on the open gate when water is at the PMF level is 302.88 kip. The margin of safety (F_R closed : F_R open) is 1.08. Therefore, there is a possibility that the open radial gate may fail when water is at the PMF. However, it is unlikely that the gates will fail by falling down into the closed position, or bending backwards (blocked by the roadway). The only possible scenario is that the gates will be torn from the trunnion and flow down the spillway crest.

BWSC — Barge Waggoner Sumner & Cannon, Inc.

Project: Hydro Static Force on Gate
Description: Diagram
Project No. ______ Sheet No. ______ of ______
Designer: ______ Date: ______
Checker: ______ Date: ______

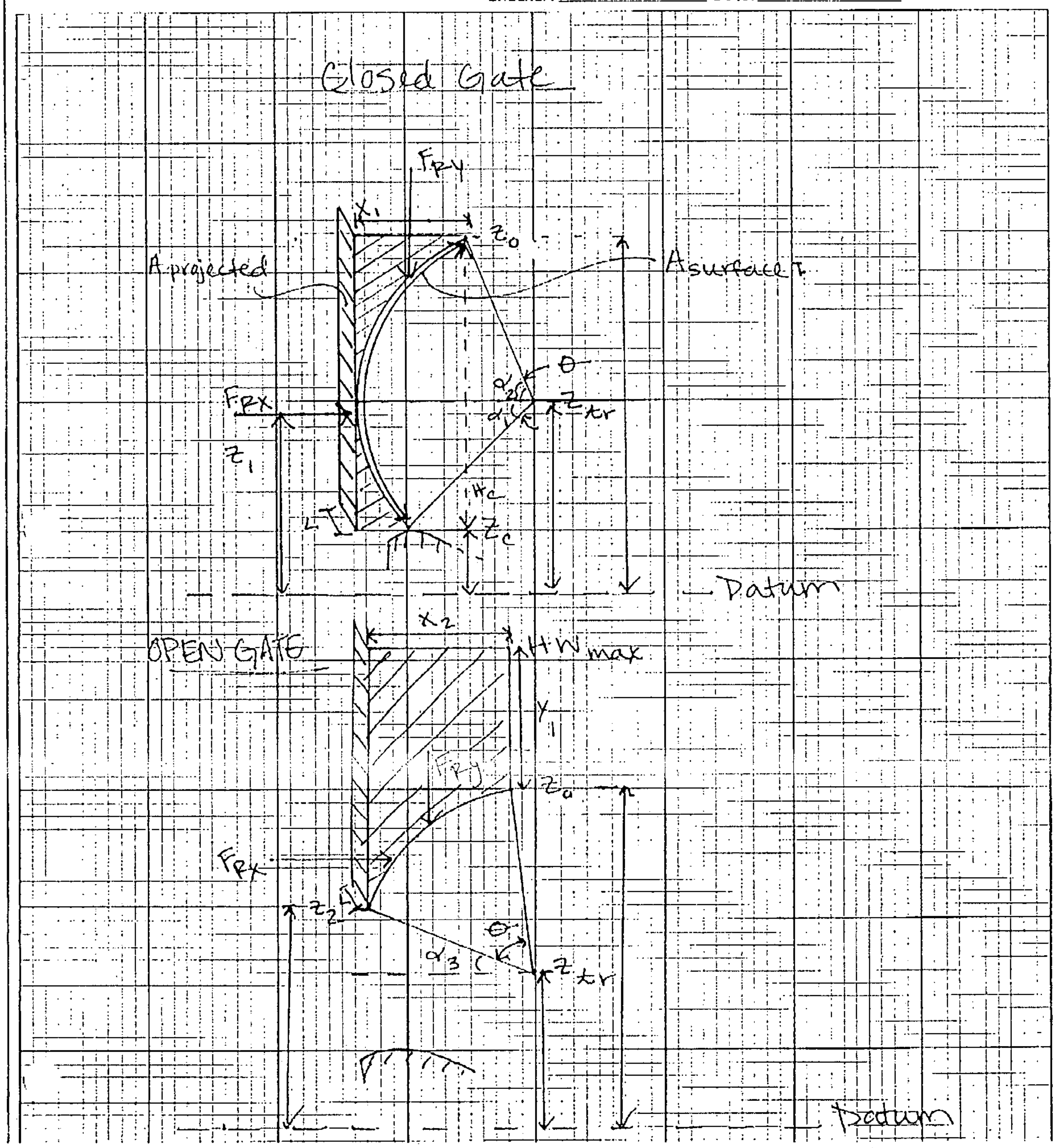


Figure C1 – Diagram of Hydrostatic Forces on Open and Closed Gates

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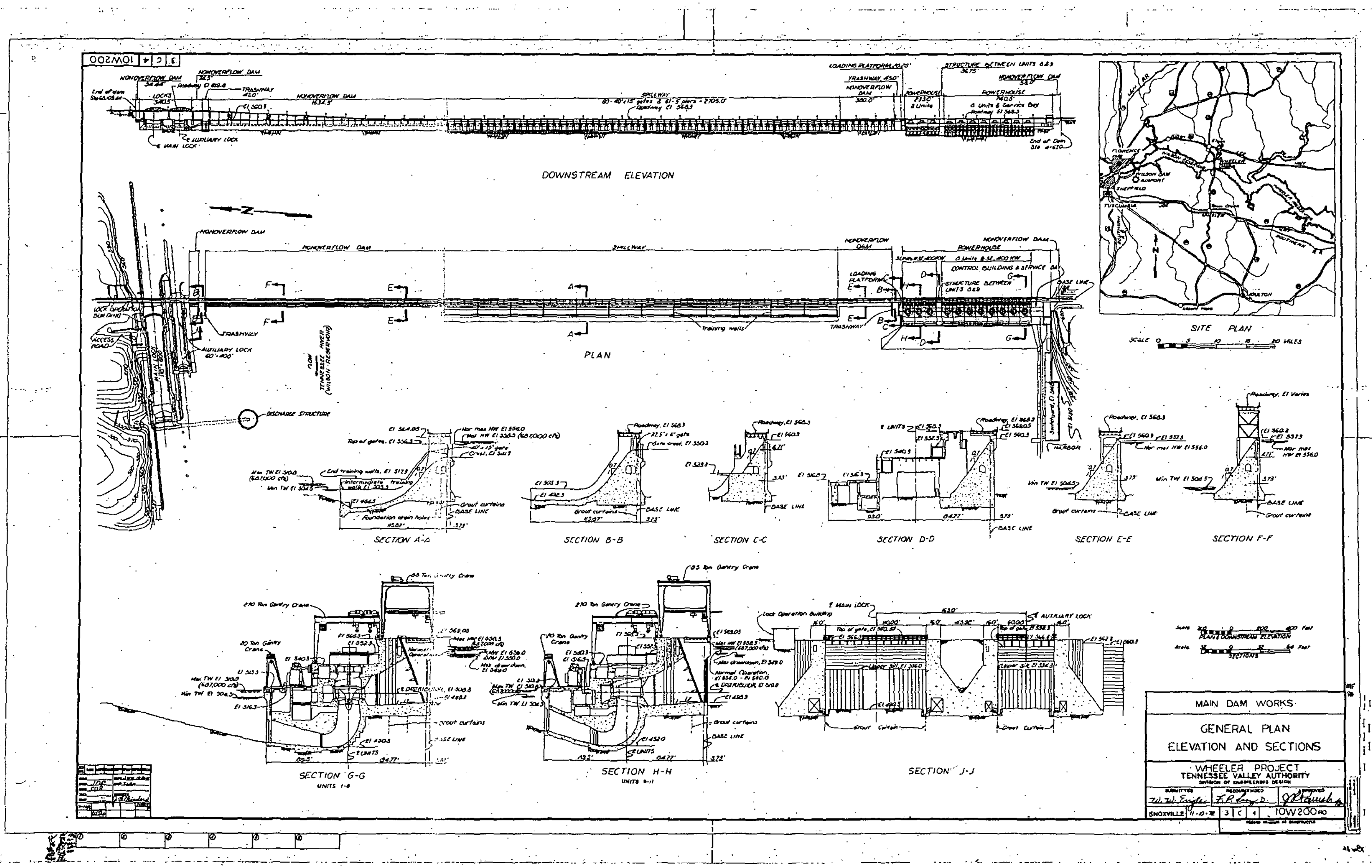
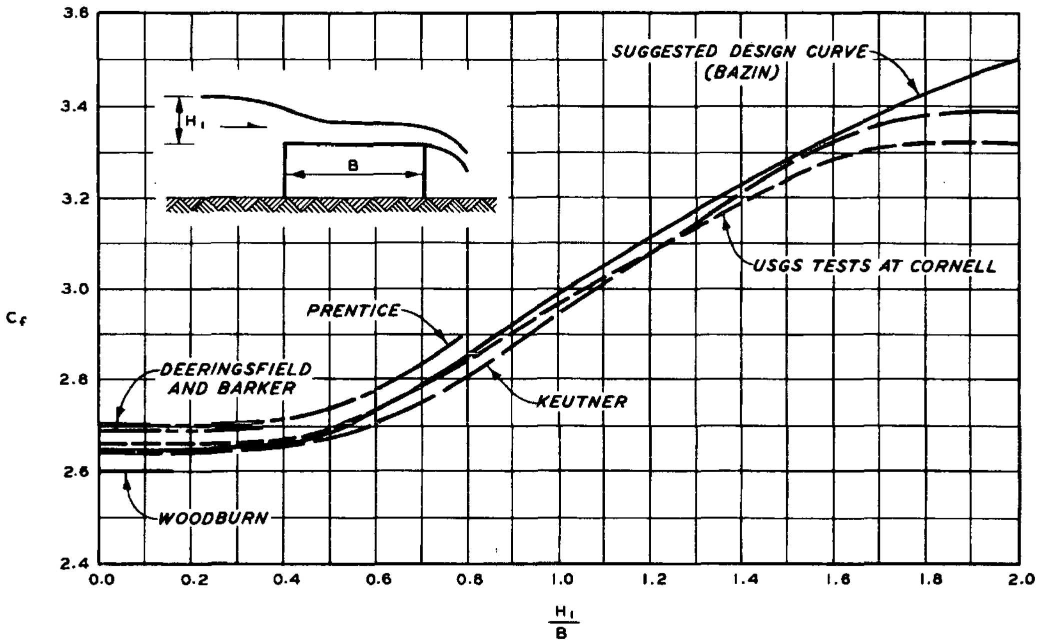
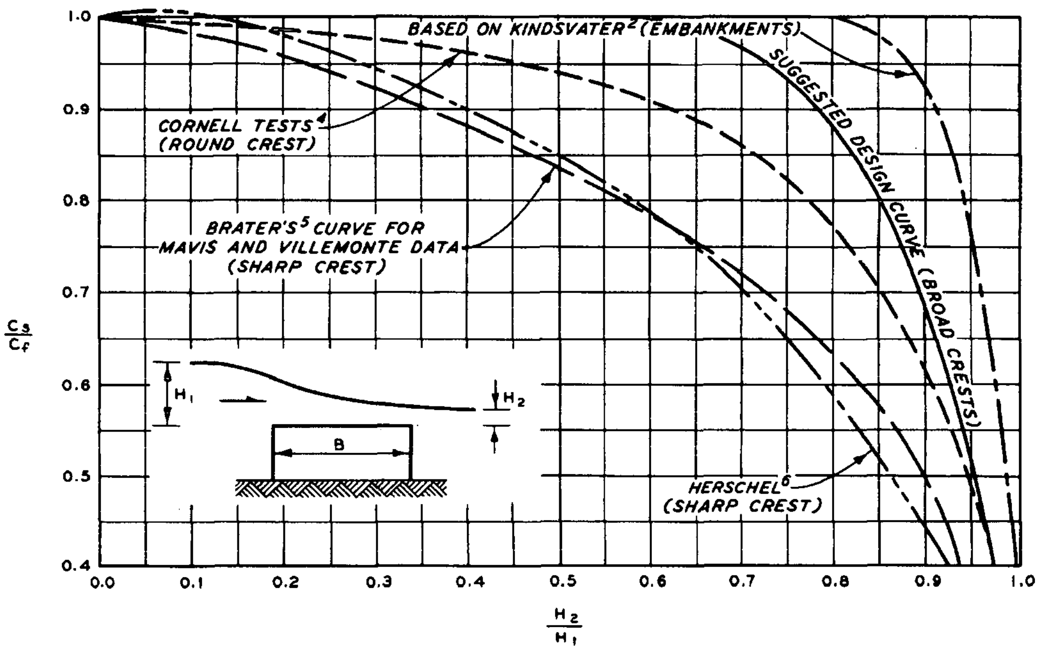
Attachment 1





a. FREE FLOW



b. SUBMERGED FLOW

NOTE: C_f = FREE-FLOW COEFFICIENT
C_s = SUBMERGED-FLOW COEFFICIENT
NEGLIGIBLE VELOCITY OF APPROACH
RAISED NUMBERS ON SUBMERGED FLOW CHART ARE REFERENCE NUMBERS FROM TEXT.

LOW-MONOLITH DIVERSION
DISCHARGE COEFFICIENTS

HYDRAULIC DESIGN CHART 711

PREPARED BY U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MISSISSIPPI

WES 1-66

CDQ000020080021

Attachment 3

WR28-2-900-123

METHOD FOR ESTIMATING DISCHARGE AT OVERFLOW SPILLWAYS WITH CURVED CRESTS AND RADIAL GATES

TENNESSEE VALLEY AUTHORITY
OFFICE OF NATURAL RESOURCES AND ECONOMIC DEVELOPMENT
DIVISION OF AIR AND WATER RESOURCES
WATER SYSTEMS DEVELOPMENT BRANCH
NORRIS, TENNESSEE

Tennessee Valley Authority
Office of Natural Resources and Economic Development
Division of Air and Water Resources
Water Systems Development Branch

METHOD FOR ESTIMATING DISCHARGE AT OVERFLOW SPILLWAYS WITH CURVED CRESTS AND RADIAL GATES

Report No. WR28-2-900-123

Prepared by
E. Dean Harshbarger,
Billy J. Clift,
and
James W. Boyd

Norris, Tennessee
January 1985

CONTENTS

LIST OF FIGURES

INTRODUCTION

The discharge at overflow spillways is determined by the spillway width, spillway gate position, a representative head (or water depth), and a discharge coefficient. For rating purposes, the spillway width and head are usually specified and the discharge coefficient is determined from scale model tests. Most of the spillways for the Tennessee Valley Authority (TVA) dams were model tested at the TVA Engineering Laboratory.

The original development of specific TVA spillway discharge coefficients (Kirkpatrick, 1957; TVA, 1962) did not establish an orderly connection between the discharge characteristics of various spillways, and therefore, the data could not be directly applied to other installations. However, revised discharge coefficient curves which did establish usable relationships were developed (TVA, 1972) and were later augmented by additional model tests. Presently data from Apalachia, Boone, Fort Patrick Henry, Hales Bar, Hiwassee, Melton Hill, Nickajack, Watts Bar and Wheeler model tests are used to define discharge coefficients with respect to gate openings, headwater elevations and crest shapes. Using these relationships, the coefficients for installations of similar design may be obtained without model testing. Discharge coefficients for Normandy Dam (TVA, 1984) were determined in this manner.

This report describes the discharge coefficient relationships established by TVA and how they are used to compute spillway rating tables for similar spillway installations in lieu of model testing.

DISCHARGE CRITERIA

The major factors which influence the discharge coefficient are the position of the gate seal point with respect to the highest point of the spillway crest, the curvature (or shape) of the crest and the curvature of the gate. Although no systematic attempt has been made to determine the quantitative effect of these factors individually, the basic trend of the coefficient data has been established with respect to crest shape. The crest shapes were identified by their relative similarity to standard crests (Creager, 1950; Corps of Engineers, 1954; Bureau of Reclamation, 1960) which approximate closely the lower portion of a free jet issuing from a sharp-crested weir.

For each standard crest shape there is a corresponding head at which flow over the crest will not separate from the surface of the crest, but will conform exactly to the crest contours. This head is termed the "standard crest design head." The TVA spillway discharge coefficient relationships are based on normalized data from the nine spillway models tested, together with standard crest design heads determined by comparing the model crest shape with standard crests.

In given situations, if the flow over the spillway crest touches or impinges upon the gate, the discharge is computed using a formula for gated discharges. If the flow does not impinge upon the gate, the discharge is computed using a formula for free discharge.

Discharge coefficients were determined for gated and free discharge using spillway models consisting of three spillway bays placed across an open channel with uniform flow. The width of the channel corresponded to the distance between the centerlines of the end piers to include the effect of flow contraction around piers. These spillway crests approximate standard crests from a point near the upstream face of the spillway to a point downstream near the gate seal point. The gate seal point is usually located below the crest elevation on the downstream portion of the crest to prevent discharge jets from overshooting the spillway for small gate openings under high heads.

The discharge nappe was unrestricted due to low tailwater elevations in the model tests. Therefore, the spillway discharge coefficient relationships do not include the effects of tailwater submergence.

GATED DISCHARGE

At multipurpose reservoirs, spillway discharge is used to regulate reservoir water levels and downstream water flowrates.

Therefore various spillway gate positions are needed to provide a range of discharge rates for each headwater elevation. To release water, the gate is raised to a predetermined position which allows a prescribed discharge to pass over the spillway crest.

The gated discharge shown in Figure 1 is determined by the area of the opening under the gate, by the water velocity through the gate opening and by the discharge coefficient of the gate opening. The area is based on the vertical distance, G, between the gate bottom point and the spillway point directly below. The water velocity is a function of the acceleration due to gravity and the mean water depth over the gate opening, H_m, defined as the distance from the surface of the headwater to the gate opening mid-point.

The equation for gated discharge through one spillway bay is:

$$Q = C\ L\ G \sqrt{2g\ H_m} \qquad (1)$$

where

- Q = discharge, ft^3/s
- C = discharge coefficient, dimensionless
- L = spillway bay width, ft
- G = vertical gate opening, ft
- g = acceleration due to gravity, ft/s^2
- H_m = head on the vertical gate opening mid-point measured from the reservoir headwater elevation, ft

The discharge coefficients were developed as a function of vertical gate opening, standard crest design head, and headwater elevation as shown in Figures 2a and 2b. The general uncertainty of the gated discharge coefficient relationship is considered to be within ± 2 percent based on the maximum deviation from the average trend. At small vertical gate openings (i.e., less that two feet) the error may be greater (Kirkpatrick, 1972).

To use Figure 2a, the headwater elevation, HL_1, at which the spillway discharge touches, but does not impinge upon the spillway gate must be determined. Starting with the desired gate opening, G, and the standard crest design head, H_o, the ratio H_c/H_o can be determined from Figure 2b. Then HL_1 can be determined by using the equation:

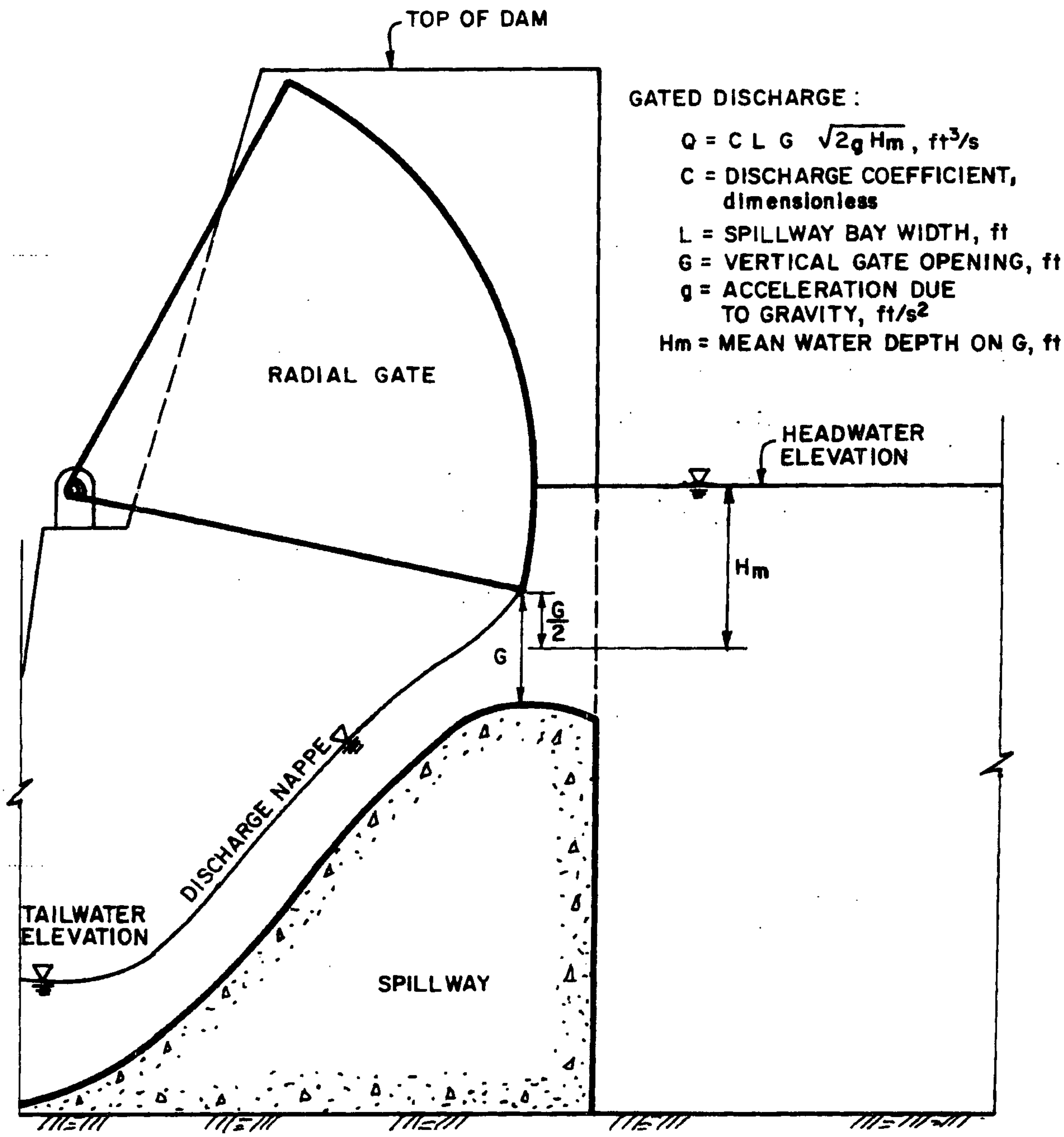


Figure I: Gated Spillway Discharge

NOTE

HL_1 = HEADWATER ELEVATION AT WHICH SPILLWAY DISCHARGE TOUCHES BUT DOES NOT IMPINGE UPON THE GATE, ft
HL = HEADWATER ELEVATION, ft
H_o = STANDARD CREST DESIGN HEAD, ft
H_c = HEAD ON CREST, ft
HL_{cr} = CREST ELEVATION, ft
H_m = HEAD ON MID-POINT OF GATE OPENING, ft
G = VERTICAL GATE OPENING, ft
L = SPILLWAY BAY WIDTH, ft
g = ACCELERATION DUE TO GRAVITY, ft/s²

COEFFICIENTS

1. FOR $HL_1 \leq HL \leq HL_5$
   $C = f(G/H_o, HL)$
2. FOR $HL > HL_5$
   $C = f(G/H_o, HL_5)$

TRANSITION HEADWATER ELEVATIONS

$HL_1 = HL_{cr} + (H_c/H_o)\,H_o$
$HL_2 = HL_1 + 0.025\,H_o$
$HL_3 = HL_1 + 0.050\,H_o$
$HL_4 = HL_1 + 0.075\,H_o$
$HL_5 = HL_1 + 0.100\,H_o$

REFERENCE DRAWINGS AEL 99 B105
AEL 99 B106

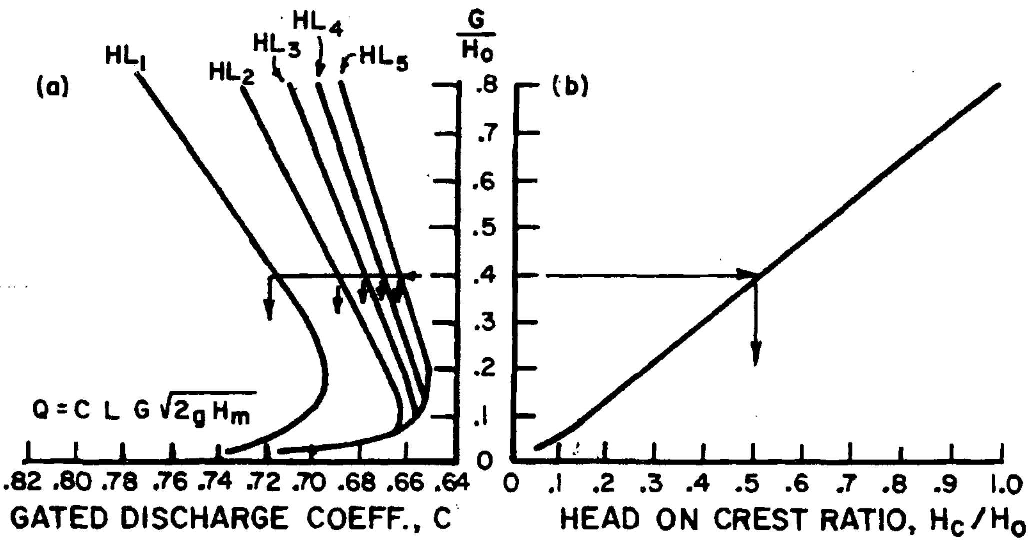


Figure 2: Gated Discharge Coefficients and Associated Headwater Elevations for Specified Gate Openings and Standard Crest Design Heads at Curved Spillways with Radial Gates

$$HL_1 = HL_{cr} + \frac{H_c}{H_o} H_o \qquad (2)$$

Where:

HL_1	=	headwater elevation at which spillway discharge touches but does not impinge upon the gate, ft
HL_{cr}	=	spillway crest elevation, ft
H_c	=	head on crest, ft
H_o	=	standard crest design head, ft
H_c/H_o	=	dimensionless ratio specified by G/H_o in Figure 2b

Once HL_1 is known, the discharge coefficients for higher headwater elevations can be determined as shown in Figure 2a. For transition headwater elevations HL_1 through HL_5 in Figure 2a, increased headwater elevation may not cause increased discharge and may even cause decreased flow because of flow contraction losses and friction losses resulting from increased water impingement upon the gate. At headwater elevations greater than HL_5 there is no significant increase in the various flow losses, and therefore the discharge coefficient is constant and equal to the discharge coefficient for headwater elevation HL_5. At small gate openings (say less than a foot), there may be little, or no transition and the discharge coefficients may be constant at some headwater elevation less than headwater elevation HL_5. The general uncertainty of the H_c/H_o vs G/H_o relationship is within ±10 percent at small vertical gate openings and ±2 percent at large openings based on the maximum deviations from the trend.

At headwater elevation HL_1, gated discharge is equal to free discharge described later in this report. However, due to the uncertainties of the discharge coefficient relationship and the H_c/H_o relationship to headwater elevation HL_1, either the gated discharge coefficient for headwater elevation HL_1 at large vertical gate openings or the headwater elevation HL_1 at small vertical gate openings may require adjustment as described later in this report to mathematically ensure gated discharge equivalent to free discharge.

In some cases, headwater elevation HL_1 may be the headwater elevation for maximum spillway discharge at the maximum vertical gate opening. This maximum spillway discharge elevation is critical in extreme flood control situations. Although the relationship between headwater HL_1 and the ratio H_c/H_o in Figures 2a and 2b is satisfactory for most spillway operations, deviations from the average trend are inherent due to variations in gate designs and locations. Other computation methods may have the same uncertainty because they require friction factors, kinetic energy factors, etc., that are best evaluated through individual model or prototype tests.

FREE DISCHARGE

Free spillway discharge occurs when water discharges freely through the vertical gate opening, as shown in Figure 3, without impinging on the gate. For each vertical gate opening, free discharge is limited by headwater elevation HL_1 previously described. The equation for free spillway discharge through a single spillway bay is:

$$Q = C\ L\ H_c^{3/2} \qquad (3)$$

in which

Q = discharge, ft^3/s
C = discharge coefficient, dimensionless
L = spillway bay width, ft
H_c = head on crest measured from the reservoir headwater elevation, ft

This equation is similar to the general equation for weirs across open channels. The free discharge coefficient varies with the head on crest, H_c, shown in Figure 3, and with the standard crest design head. The relationship between discharge coefficients, head on crest, and the standard crest design head is shown in Figure 4. The uncertainty of the discharge coefficient relationship is within ± 1 percent based on the maximum deviation from the average trend (Kirkpatrick, 1972).

GATE ARRANGEMENTS AND IDENTIFICATION

Gate opening arrangement, or the pattern of open gates across the spillway is important at installations with several spillway bays and

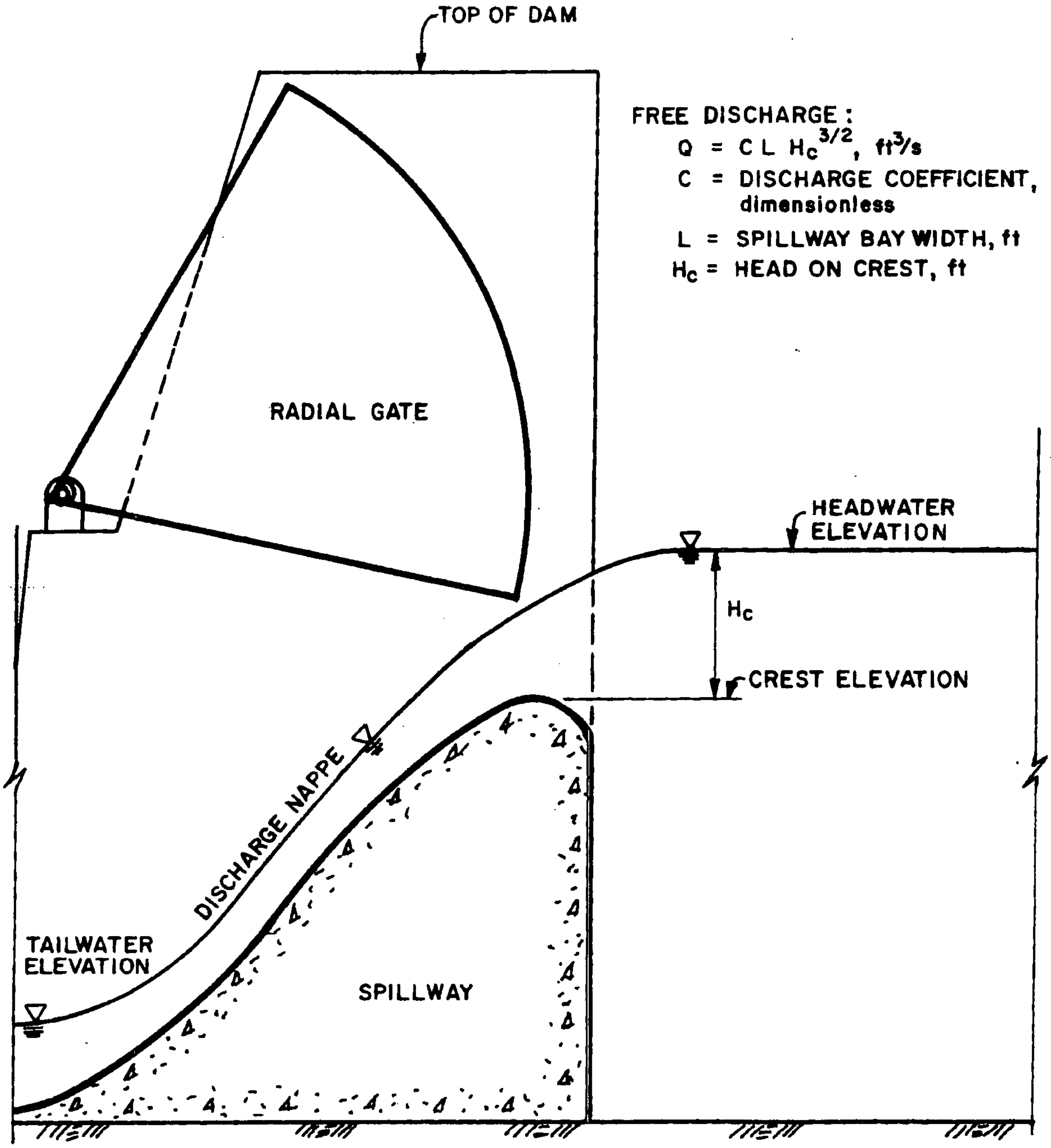


Figure 3: Free Spillway Discharge

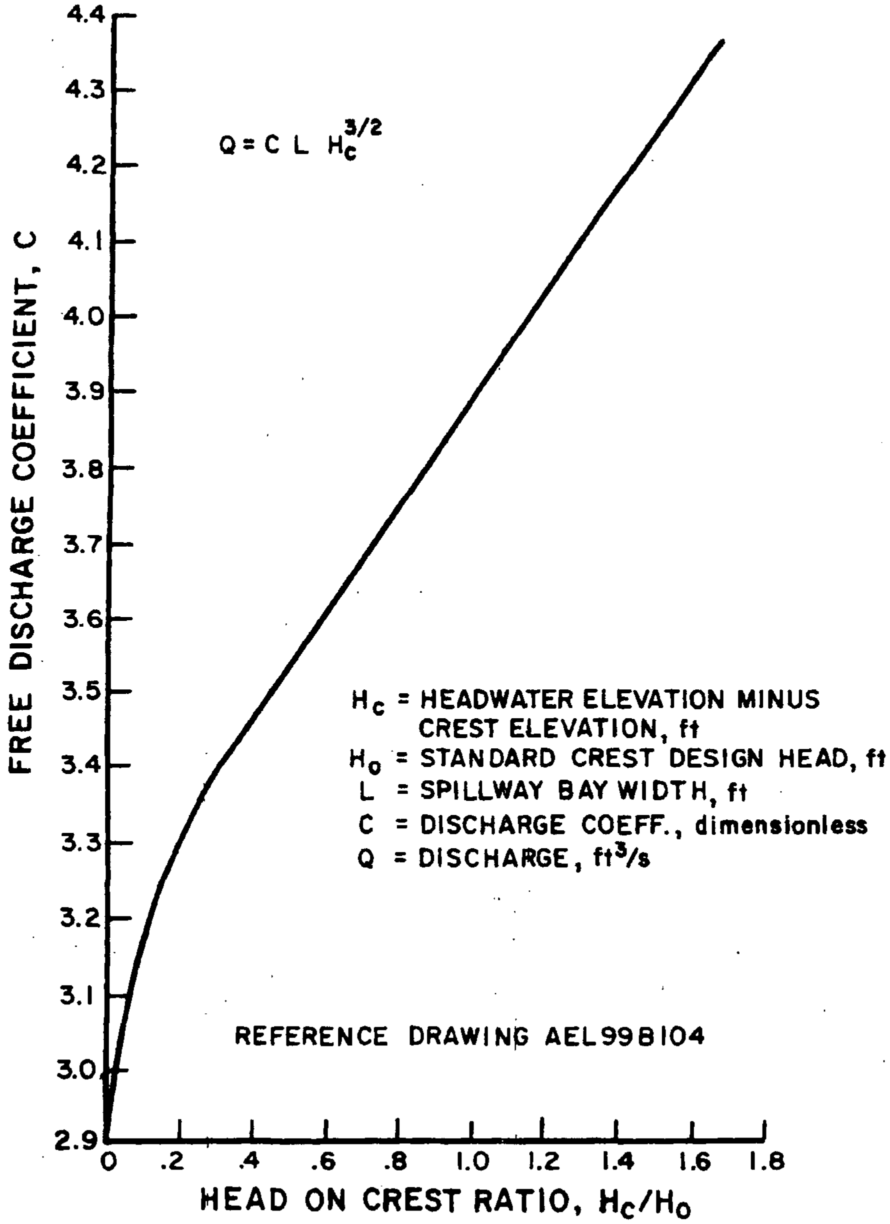


Figure 4: Free Discharge Coefficients for Specified Headwater Elevations and Standard Crest Design Heads at Curved Spillways

gates. Some gate opening arrangements will produce flow patterns in the stilling basin that are hazardous to the structural stability of the dam and stilling basin and to navigation downstream.

In practice, each gate is assigned an identification number and a diagram showing the spillway gate number and location is included in the spillway rating tables. For a given flow and headwater elevation, the gates to be opened and the required amount of opening to obtain the given flow are identified by a specific gate arrangement number. Increasing gate arrangement number indicates increasing flow.

RATING TABLES

Spillway rating tables are used for daily water control operations and water control planning. For each gate arrangement number, discharge rates are listed as a function of headwater elevation. At multiple gate spillways, the listed discharge represents the total discharge for the gate positions prescribed in the table of gate arrangements. The primary purpose of the spillway rating table is to determine the appropriate gate opening arrangements required to pass the listed discharge for the given headwater elevation. The alternate use is to determine the discharge for a given gate arrangement and headwater elevation.

Only discrete discharge rates are listed in the rating table. In the event that a preferred rate is not listed, the rate nearest to it should be used to minimize gate arrangement adjustments and to avoid using gate arrangements not authorized in the rating table.

The TVA discharge coefficient relationships can be used in lieu of calibration data to prepare rating tables for spillways that meet conditions of geometric similitude and have an established table of gate arrangements. Seven major parameters must be evaluated for each spillway rating.

1. Standard crest design head: determined by crest shape.
2. Vertical gate openings: determined by gate positions.
3. Gated discharge headwater elevations: determined for each gate opening by the relationships in Figures 2a and 2b for

transitional headwater elevations based on headwater elevation HL_1. Note adjustment listed in (4) below for headwater elevation HL_1.

4. Gated discharge coefficients: with minor adjustments, they are determined for each vertical gate opening and headwater elevation by the relationships in Figure 2a. At headwater elevation HL_1, the gated discharge must be equivalent to free discharge. However, due to the uncertainties of the discharge relationships, the gated and free discharge equations may not converge. In this case, the gated discharge coefficient is adjusted so that the gated discharge from equation (1) is equal to the free discharge from equation (3). Also the adjusted gated discharge coefficient at headwater elevation HL_1 must not be less than the constant gated discharge coefficient at headwater elevation HL_5. If the coefficient must be readjusted to be equal to the constant coefficient, headwater elevation HL_1 must be adjusted also by using equations (1) and (3) which are solved iteratively to establish headwater elevation HL_1 for equivalent discharges.

   After adjustment, the coefficients are plotted as a function of transitional headwater elevation. An average, monotonically-decreasing curve is drawn to pass through the maximum and minimum coefficient points to define interpolated coefficients in the transitional headwater range. For headwaters greater than the transitional headwaters, the discharge coefficient is constant and equal to the minimum coefficient. At small gate openings, the interpolated coefficients may be equal or they may become equal at some headwater within the transitional headwater range.

5. Free discharge coefficients: determined for each crest elevation and headwater elevations less than, or equal to headwater elevation HL_1, by the relationship in Figure 4.

6. Adjacent gate effect: the discharge coeffieients include the effect of flow contraction around spillway piers when the gate

openings for adjacent bays are equal. Although reduced discharge occurs due to contractions at piers between adjacent gates with dissimilar gate openings (Kirkpatrick, 1957), the reduction is not significant when compared with the accuracy of discharge coefficient relationships where interior adjacent gate openings do not vary more than one position. At end gates, the dam abutment may have the same effect as a closed gate. Where the abutment approximates one gate, the estimated end gate discharge reduction varies from one percent at median gate positions to three percent at the maximum gate position. If the approach channel corresponds to the spillway end piers, there is no discharge reduction.

7. Overtopping discharge: the spillway discharge coefficent relationships cannot be used to estimate discharge over the gates or over the dam. At small gate openings, the top of the gate elevation may be lower than the top of the dam elevation and, therefore, gated discharge headwater elevations must not exceed the top of the gate elevation in discharge calculations for small gate openings.

A representative discharge rating curve for one gate is shown in Figure 5. Some, or all, gates at a particular dam may have identical discharge characteristics at all gate positions and will have duplicate discharge rating curves. Discharge rates for each gate arrangement are determined by summing individual rates according to the prescribed gates, gate positions, and headwater elevations for each gate arrangement number. The spillway rating table normally lists discharge rates to the nearest 10 cubic feet per second for rates less than 100,000 and to the nearest 100 cubic feet per second at higher rates.

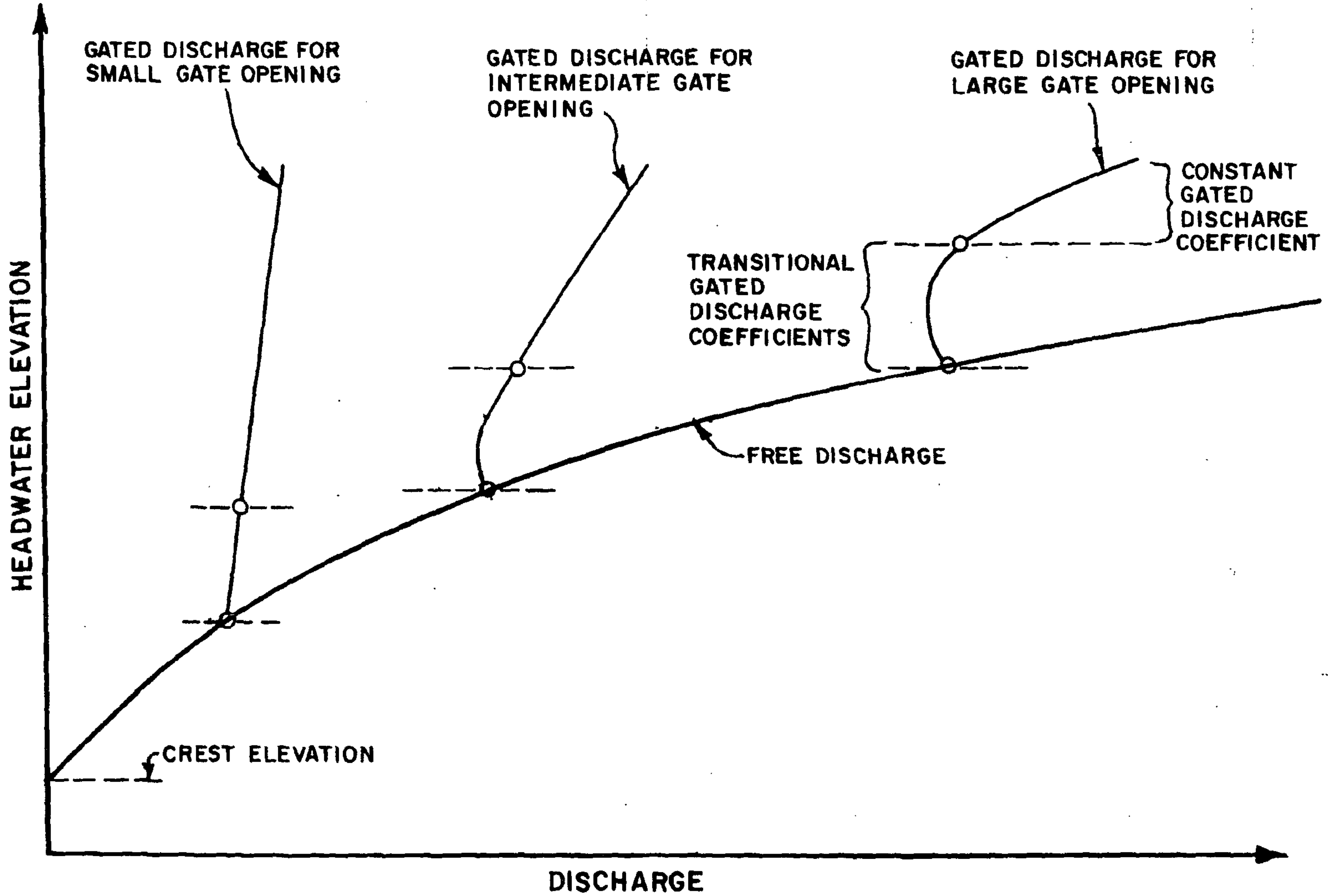


Figure 5: Representative Discharge Curve for a Radial Gate Over a Curved Spillway

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Tennessee Valley Authority
Division of Water Control Planning
Engineering Laboratory

TAINTER GATE RATING DATA
DETERMINED FROM EIGHT TVA MODEL STUDIES

Norris, Tennessee
March 1962

TAINTER GATE RATING DATA

DETERMINED FROM EIGHT TVA MODEL STUDIES

CONTENTS

Tennessee Valley Authority

Tainter Gate Ratings

Basic Model and Prototype Data

Project	MODEL					PROTOTYPE		
	Model Scale	No. of Spill-way Bays	Crest Length L	Approach Width W	Up-stream Depth P	Crest Elev.	Design Head H_o	Pier Nose Radius R
Apalachia	1:28.72	6	6.684	8.00	3.38	1257.0	23.0	3.00
Boone	1:50	5	3.480	(1)	(1)	1350.0	35.0	12.75[2] 11.25[3] 3.50[4]
Ft. Patrick Henry	1:15	1	2.333[5]	2.77[5]	2.29	1228.0	35.0	3.25
Hales Bar	1:34.76	6	6.908[6] 6.905[7]	7.94	0.921	616.0	18.0	3.00
Hiwassee	1:55	7	4.050	8.00	6.35	1503.5		3.00
Watts Bar	1:35	6	6.866	8.00	1.5	713.0	23.5	3.25
Wheeler	1:34.35	6	6.984	7.97	1.253	541.3	16.5	2.50

(1) Variable because approach was reproduced in model.

(2) Right end pier.

(3) Left end pier.

(4) Intermediate piers.

(5) Except as noted on data tabulations.

(6) Gates partially opened.

(7) Gates raised above water surface.

Definition of Symbols

Q	=	Total discharge in cubic feet per second.
D	=	Depth of flow above crest in feet.+
D_1	=	Depth, bottom of gate to water surface.*
H	=	Total head above crest, including velocity head of approach in feet.*
H_o	=	Design head for standard crest, including velocity head of approach, in feet.
h	=	Velocity head of approach in feet.*
C	=	Coefficient of discharge for any head.
G.O.	=	Gate opening - vertical distance above spillway crest in feet.
b	=	Shortest distance between spillway surface and gate lip in feet.*
L	=	Length of spillway crest in feet.
P	=	Depth of model approach channel, crest to river bed, in feet.+
W	=	Width of model approach in feet.
x	=	Horizontal distance from upstream face of dam in feet.*
y	=	Vertical distance above spillway crest in feet.*

Discharge Equations

For flow under a gate:

$$Q = CL \left[H^{3/2} - (D_1 + h)^{3/2}\right] \qquad (A)$$

For flow over a spillway crest with the spillway gate raised above the water surface:

$$Q = CLH^{3/2} \qquad (B)$$

+See Figure 1(a) on page 4.
*See Figure 1(b) on page 4.

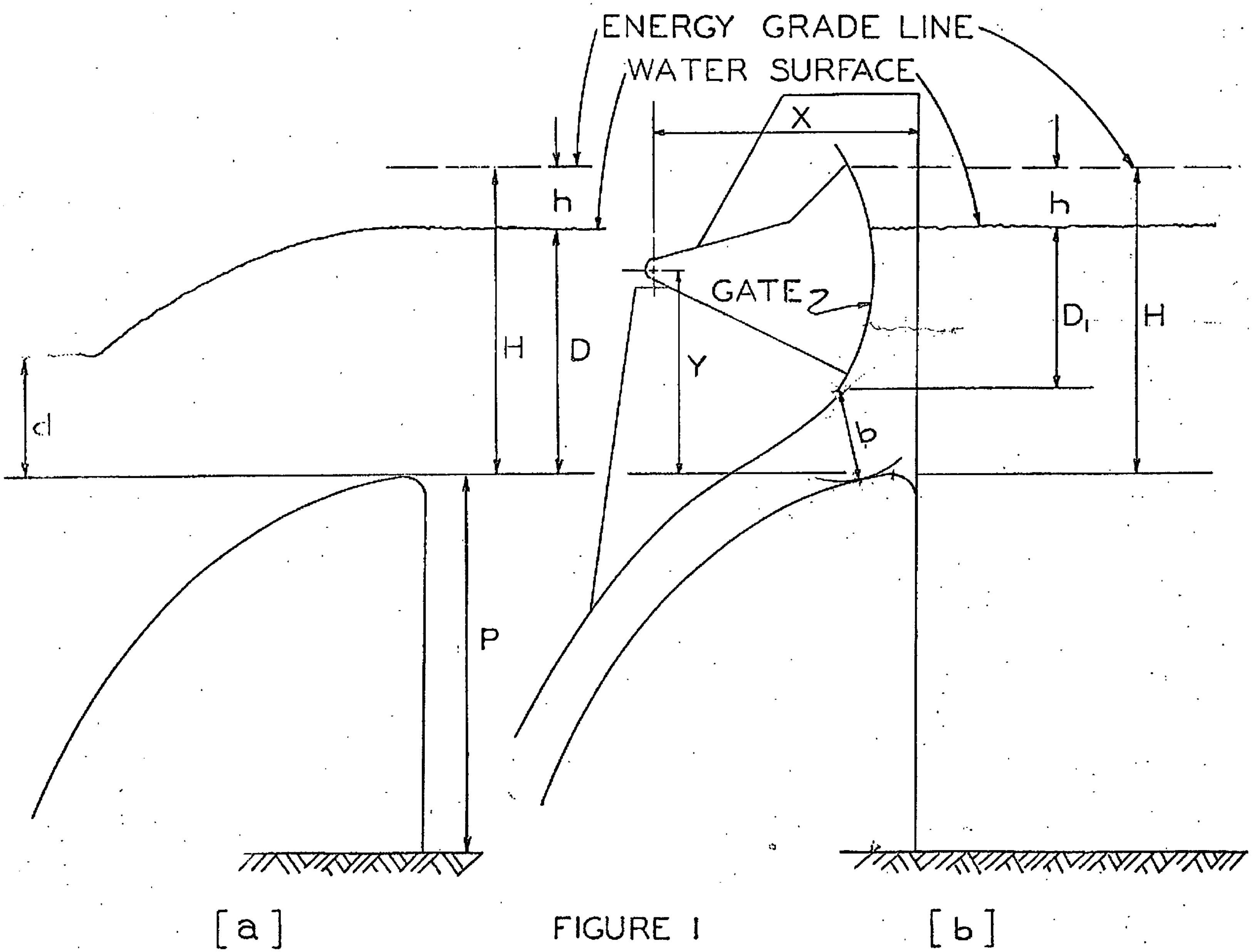


FIGURE 1

Tennessee Valley Authority

Apalachia Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.0532	0.117	0.826	0.000	1.53	3.36	3,650	3.09+ 5.19*
	0.154	0.828	0.000		4.42	3,660	4.38
	0.251	1.071	0.000		7.21	4,734	4.25
	0.358	1.305	0.000		10.28	5,769	4.26
	0.449	1.472	0.000		12.90	6,507	4.26
	0.533	1.618	0.000		15.31	7,152	4.28
	0.663	1.812	0.000		19.04	8,010	4.27
	0.778	1.973	0.000		22.34	8,721	4.28
	0.886	2.115	0.000		25.45	9,349	4.29
0.1107	0.190	1.796	0.000	3.18	5.46	7,939	3.25+ 4.43*
	0.246	1.838	0.000		7.07	8,125	3.80
	0.287	1.994	0.000		8.24	8,814	3.73
	0.367	2.302	0.000		10.54	10,180	3.71
	0.450	2.595	0.000		12.92	11,470	3.72
	0.549	2.916	0.000		15.77	12,890	3.73
	0.627	3.137	0.000		18.01	13,870	3.73
	0.732	3.451	0.000		21.02	15,250	3.77
	0.831	3.681	0.000		23.87	16,270	3.76
	0.917	3.888	0.000		26.34	17,190	3.76
0.1676	0.257	2.888	0.000	4.81	7.38	12,770	3.32+ 4.17*
	0.303	2.890	0.000		8.70	12,770	3.69
	0.393	3.330	0.000		11.29	14,720	3.57
	0.469	3.709	0.000		13.47	16,400	3.57
	0.545	4.066	0.000		15.65	17,970	3.56
	0.631	4.444	0.000		18.12	19,640	3.57
	0.739	4.866	0.000		21.22	21,510	3.57
	0.373	3.221	0.000		10.71	14,240	3.57
	0.322	2.977	0.000		9.25	13,160	3.64
	0.811	5.124	0.000		23.29	22,650	3.57
	0.894	5.418	0.000		25.68	23,950	3.58

*Gate lip touching nappe C from Equation A.
+Gate lip touching nappe C from Equation B.

Tennessee Valley Authority

Apalachia Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.2247	0.364	4.184	0.000	6.45	10.45	18,490	3.73
	0.318	4.098	0.000		9.13	18,110	3.42+ 4.08*
	0.411	4.399	0.000		11.80	19,450	3.59
	0.461	4.752	0.000		13.24	21,010	3.58
	0.531	5.181	0.000		15.25	22,900	3.56
	0.627	5.742	0.001		18.04	25,380	3.54
	0.718	6.224	0.001		20.65	27,510	3.55
	0.825	6.771	0.001		23.72	29,930	3.56
	0.911	7.179	0.001		26.19	31,730	3.56
0.3393	0.469	7.647	0.001	9.74	13.50	33,800	3.55+ 4.16*
	0.526	7.490	0.001		15.14	33,110	3.72
	0.574	7.832	0.001		16.51	34,620	3.65
	0.631	8.344	0.001		18.15	36,880	3.63
	0.717	9.089	0.001		20.62	40,180	3.63
	0.821	9.882	0.001		23.61	43,680	3.61
	0.919	10.58	0.002		26.42	46,770	3.62
0.4541	0.604	11.54	0.002	13.04	17.40	51,010	3.66+ 4.19*
	0.617	11.84	0.002		17.78	52,340	4.22
	0.720	11.84	0.002		20.74	52,340	3.73
	0.668	11.42	0.002		19.24	50,480	3.81
	0.765	12.34	0.002		22.03	54,550	3.72
	0.838	13.10	0.002		24.12	57,910	3.70
	0.915	13.84	0.003		26.36	61,180	3.68
0.5677	0.751	16.55	0.004	16.30	21.68	73,160	3.77+ 4.31*
	0.895	17.14	0.004		25.82	75,770	3.87
	0.849	16.72	0.004		24.50	73,910	3.94
	0.815	16.24	0.004		23.52	71,790	3.95

*Gate lip touching nappe C from Equation A.
+Gate lip touching nappe C from Equation B.

Tennessee Valley Authority

Apalachia Project

Tainter Gates Raised Above Water Surface

MODEL TEST DATA			EQUIVALENT PROTOTYPE		
D ft.	Q cfs	h ft.	H ft.	Q cfs	C
0.117	0.826	0.000	3.36	3,651	3.09
0.190	1.796	0.000	5.46	7,939	3.25
0.257	2.888	0.000	7.38	12,770	3.32
0.318	4.098	0.000	9.13	18,110	3.42
0.397	5.813	0.001	11.42	25,700	3.46
0.466	7.542	0.001	13.41	33,340	3.54
0.536	9.512	0.001	15.43	42,050	3.62
0.592	11.17	0.002	17.06	49,380	3.65
0.659	13.39	0.003	19.00	59,190	3.72
0.728	15.80	0.004	21.01	69,840	3.77
0.800	18.66	0.005	23.12	82,480	3.86
0.866	21.57	0.006	25.05	95,350	3.96
0.894	22.44	0.007	25.87	99,190	3.93
0.469	7.647	0.001	13.50	33,800	3.55
0.604	11.54	0.002	17.40	51,010	3.66
0.751	16.55	0.004	21.68	73,160	3.77

Tennessee Valley Authority

Boone Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.040	0.085	0.2810		2.00	4.25	4,968	3.26+ 5.28*
	0.149	0.3552			7.45	6,279	4.74
	0.234	0.4567			11.70	8,073	4.72
	0.274	0.4937			13.70	8,727	4.70
	0.351	0.5661			17.55	10,010	4.70
	0.428	0.6285			21.40	11,110	4.72
	0.504	0.6857			25.20	12,120	4.73
	0.581	0.7385			29.05	13,050	4.72
	0.626	0.7663			31.30	13,550	4.71
	0.700	0.8087			35.00	14,300	4.69
	0.110	0.3020			5.50	5,339	4.82
0.500	0.617	6.250		25.00	30.85	110,500	3.70+ 4.04*
	0.680	6.598	Negligible		34.00	116,600	3.92
	0.721	6.715			36.03	118,700	3.80
	0.633	6.456			33.15	114,100	3.91
0.400	0.493	4.355		20.00	24.65	76,990	3.61+ 3.93*
	0.558	4.638			27.90	81,990	3.77
	0.615	4.906			30.75	86,730	3.69
	0.685	5.279			34.25	93,320	3.66
	0.708	5.425			35.40	95,900	3.67
0.300	0.379	2.964		15.00	18.95	52,400	3.65+ 4.04*
	0.459	3.175			22.95	56,130	3.68
	0.517	3.453			25.85	61,040	3.67
	0.575	3.726			28.75	65,870	3.67
	0.648	4.044			32.40	71,490	3.67
	0.724	4.344			36.20	76,790	3.67

*Gate lip touching nappe C from Equation A.
+Gate lip touching nappe C from Equation B.

Tennessee Valley Authority

Boone Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.200	0.270	1.672		10.00	13.50	29,560	3.42+ 3.94*
	0.334	1.856			16.70	32,810	3.71
	0.409	2.133			20.45	37,710	3.69
	0.469	2.413			23.45	42,660	3.82
	0.539	2.626			26.95	46,420	3.80
	0.592	2.790			29.60	49,320	3.82
	0.670	2.896			33.50	51,200	3.68
	0.723	3.035			36.15	53,650	3.69
0.100	0.152	0.7015	Negligible	5.00	7.60	12,400	3.40+ 4.25*
	0.218	0.8119			10.90	14,350	3.81
	0.264	0.9232			13.20	16,320	3.83
	0.334	1.061			16.70	18,760	3.82
	0.391	1.174			19.55	20,750	3.86
	0.474	1.311			23.70	23,180	3.86
	0.599	1.496			29.95	26,450	3.87
	0.537	1.403			26.85	24,800	3.85
	0.630	1.537			31.50	27,170	3.87
	0.719	1.654			35.95	29,240	3.87
	0.177	0.7320			8.85	12,940	3.96
	0.234	0.8555			11.70	15,120	3.84
	0.299	0.9897			14.95	17,500	3.81

*Gate lip touching nappe C from Equation A.
+Gate lip touching nappe C from Equation B.

Tennessee Valley Authority

Boone Project

Tainter Gates Raised Above Water Surface

MODEL TEST DATA			EQUIVALENT PROTOTYPE		
D ft.	Q cfs	h ft.	H ft.	Q cfs	C
0.323	2.312	Negligible	16.15	40,870	3.62
0.367	2.928		18.35	51,760	3.79
0.432	3.575		21.60	63,200	3.62
0.492	4.399		24.60	77,770	3.66
0.545	5.166		27.25	91,320	3.69
0.609	6.155		30.45	108,800	3.72
0.664	7.044		33.20	124.500	3.74
0.706	7.809		35.30	138,000	3.78
0.252	1.522		12.60	26,910	3.46
0.190	0.9783		9.50	17,290	3.39
0.135	0.5736		6.75	10,140	3.33
0.088	0.2952		4.40	5,220	3.25
0.048	0.1170		2.40	2,068	3.21

Tennessee Valley Authority

Fort Patrick Henry Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.200	2.214	4.040	0.000	3.00	33.21	3,520	3.97
	2.530	4.332	0.000		37.95	3,775	3.97
	1.714	3.511	0.000		25.71	3,060	3.95
	1.412	3.156	0.000		21.18	2,750	3.94
	1.110	2.755	0.000		16.65	2,401	3.92
	0.683	2.076	0.000		10.24	1,809	3.89
	0.556	1.831	0.000		8.34	1,596	3.88
	0.500	1.711	0.000		7.50	1,491	3.88
	0.424	1.552	0.000		6.36	1,352	3.91
	0.350	1.515	0.000		5.25	1,320	4.36
	0.362	1.510	0.000		5.43	1,316	4.24
	0.360	1.578	0.000		5.40	1,375	4.45
0.333	1.464	4.895	0.003	5.00	22.00	4,266	3.69
	1.133	4.218	0.003		17.04	3,676	3.68
	0.917	3.692	0.003		13.80	3,217	3.66
	0.742	3.217	0.002		11.16	2,803	3.65
	1.692	5.331	0.004		25.44	4,646	3.70
	1.913	5.716	0.004		28.76	4,981	3.71
0.667	1.226	7.822	0.010	10.00	18.54	6,816	3.55
	2.108	11.21	0.013		31.82	9,768	3.60
	1.556	9.169	0.012		23.52	7,990	3.55
	1.915	10.59	0.013		28.92	9,230	3.60
	0.995	6.828	0.009		15.06	5,950	3.61
	2.186	11.46	0.013		32.99	9,986	3.60
1.133	1.625	15.23	0.030	17.00	24.83	13,270	3.73
	1.947	17.28	0.034		29.72	15,060	3.69
	2.124	18.33	0.035		32.39	15,970	3.68
	2.361	19.68	0.036		35.96	17,150	3.68
1.400	1.966	21.05	0.049	21.00	30.22	18,340	3.79
	2.105	22.08	0.051		32.34	19,240	3.77
	2.359	23.67	0.052		36.16	20,630	3.72
	1.925	20.72	0.049		29.61	18,060	3.80
	1.925	20.83	0.049		29.61	18,150	3.82
	1.828	20.11	0.048		28.14	17,520	3.84
	1.807	20.03	0.048		27.82	17,460	3.87
	1.786	19.94	0.048		27.51	17,380	3.89
	1.766	19.92	0.049		27.22	17,360	3.92

Tennessee Valley Authority

Fort Patrick Henry Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
1.667	2.326	27.84	0.073	25.00	35.98	24,260	3.86
	2.296	27.65	0.073		35.49	24,100	3.88
	2.253	27.40	0.073		34.89	23,880	3.89
	2.233	27.26	0.073		34.59	23,760	3.91
	2.179	26.96	0.073		33.78	23,493	3.94
	2.144	26.74	0.073		33.26	23,300	3.96
	1.995	27.89	0.086		31.22	24,304	4.37
0.867	2.396	15.55	0.022	13.00	36.27	13,550	3.65
	2.036	13.99	0.021		30.86	12,190	3.63
	1.756	12.66	0.020		26.64	11,030	3.62
	1.408	10.85	0.018		21.39	9,455	3.62
	1.281	10.15	0.016		19.46	8,845	3.64
	1.070	9.504	0.016		16.29	8,282	3.96
	1.149	9.582	0.016		17.48	8,350	3.75
	1.136	9.548	0.016		17.28	8,320	3.77
0.533	1.141	6.240	0.007	8.00	17.22	5,438	3.58
	1.466	7.389	0.008		22.11	6,439	3.61
	1.797	8.391	0.008		27.08	7,312	3.63
	2.378	9.885	0.009		35.80	8,614	3.64
0.433	1.991	7.402	0.006	6.50	29.96	6,450	3.66
	1.595	6.497	0.006		24.02	5,662	3.65
	1.238	5.544	0.005		18.64	4,831	3.62
	0.765	4.036	0.004		11.54	3,517	3.61

Tennessee Valley Authority

Fort Patrick Henry Project

Tainter Gates Raised Above Water Surface

MODEL TEST DATA			EQUIVALENT PROTOTYPE		
D	Q	h	H	Q	C
ft.	cfs	ft.	ft.	cfs	
1.274	13.09	0.027	19.52	11,410	3.78
1.440	16.17	0.038	22.17	14,090	3.86
1.691	21.55	0.059	26.25	18,780	3.99
1.890	26.26	0.080	29.55	22,880	4.07
1.972	28.34	0.090	30.93	24,700	4.10
0.9916	8.551	0.014	15.09	7,451	3.63
0.8044	6.045	0.008	12.18	5,268	3.54
0.5831	3.578	0.003	8.79	3,118	3.42
0.3610	1.673	0.001	5.43	1,458	3.29

This is for special 1:15 model tests in which Fort Pat crest was replaced with a standard crest for comparison purposes.

Tennessee Valley Authority

Fort Patrick Henry Project

Tainter Gates Partially Opened

Gate Trunnion at Various Locations

MODEL TEST DATA

b ft.	L ft.	Trunnion Locations x ft.	Trunnion Locations y ft.	D ft.	h ft.	Q cfs
0.200	2.325	2.486	1.430	3.069	0.001	4.388
				3.048	0.001	4.374
				2.124	0.001	3.605
				1.282	0.001	2.734
				0.577	0.001	1.700
				0.283	0.000	0.999
0.203	2.325	2.808	0.550	0.601	0.001	1.714
				1.361	0.001	2.757
				2.240	0.001	3.600
				2.771	0.001	4.016
0.200	2.325	2.808	0.550	0.217	0.000	0.745
				0.402	0.001	1.309
				0.934	0.001	2.210
				1.882	0.001	3.244
				2.720	0.001	3.912
0.200	2.325	2.822	-0.077	1.389	0.001	2.652
				2.444	0.001	3.590
				1.945	0.001	3.180
				0.539	0.001	1.556
0.701	2.320	2.410	1.924	2.959	0.017	15.14
				2.374	0.017	13.27
				1.856	0.015	11.32
				0.970	0.009	6.688
				1.393	0.013	9.186
0.700	2.320	2.732	1.044	0.952	0.008	6.469
				1.525	0.012	9.396
				2.189	0.015	11.95
				3.047	0.015	14.52
0.700	2.320	2.746	0.417	0.795	0.007	5.691
				0.893	0.008	6.140
				1.488	0.012	9.080
				2.150	0.014	11.50
				2.727	0.014	13.25
1.199	2.320	2.333	2.418	1.305	0.027	12.94
				1.434	0.029	13.97
				1.641	0.035	16.00
				2.117	0.043	20.00
				2.765	0.048	24.40

Width of model approach channel (W) = 2.74 ft.
Model layout is shown on page 44.

Tennessee Valley Authority

Fort Patrick Henry Project

Tainter Gates Partially Opened

Gate Trunnion at Various Locations

MODEL TEST DATA

b ft.	L ft.	Trunnion Locations x ft.	Trunnion Locations y ft.	D ft.	h ft.	Q cfs
1.199	2.320	2.655	1.538	2.746	0.045	23.29
				2.337	0.042	20.77
				1.787	0.036	16.90
				1.444	0.028	13.89
1.199	2.320	2.669	0.911	1.500	0.030	14.34
				1.803	0.036	16.92
				2.389	0.042	20.84
				2.851	0.043	23.43
1.698	2.320	2.579	2.032	1.926	0.065	23.58
				2.173	0.073	26.47
				2.465	0.080	29.47
1.701	2.320	2.593	1.405	1.798	0.063	22.55
				1.978	0.067	24.25
				2.278	0.076	27.62
				2.456	0.080	29.49
0.199	2.328	2.397	1.897	0.546	0.001	1.699
				1.129	0.001	2.698
				1.944	0.002	3.668
				2.949	0.002	4.594
0.199	2.328	2.917	1.118	2.835	0.001	4.102
				2.103	0.001	3.501
				1.276	0.001	2.661
				0.620	0.001	1.731
0.197	2.329	3.100	0.200	0.651	0.001	1.703
				1.461	0.001	2.693
				2.470	0.001	3.565
				3.099	0.001	4.013
0.198	2.329	3.018	-0.421	0.570	0.001	1.583
				1.439	0.001	2.645
				1.950	0.001	3.112
				2.549	0.001	3.534
0.200	2.328	3.018	-0.421	0.298	0.000	1.219
				0.424	0.001	1.346
				1.022	0.001	2.217

Width of model approach channel (W) = 2.74 ft.
Model layout is shown on page 44.

Tennessee Valley Authority

Fort Patrick Henry Project

Tainter Gates Partially Opened

Gate Trunnion at Various Locations

MODEL TEST DATA

b	L	Trunnion Locations x	Trunnion Locations y	D	h	Q
ft.	ft.	ft.	ft.	ft.	ft.	cfs
0.699	2.328	2.397	2.397	1.000	0.010	7.197
				1.338	0.013	9.270
				1.623	0.016	10.78
				2.074	0.018	12.86
				2.547	0.019	14.64
				2.862	0.019	15.71
0.699	2.328	2.917	1.618	1.007	0.010	7.094
				1.585	0.014	9.894
				2.199	0.016	12.31
				2.848	0.017	14.48
0.699	2.328	3.100	0.700	0.923	0.010	7.094
				1.036	0.010	7.133
				1.619	0.013	9.609
				2.163	0.014	11.60
				2.894	0.015	13.76
0.701	2.328	3.018	0.079	1.028	0.010	7.107
				1.663	0.012	9.609
				2.234	0.013	11.46
				2.911	0.014	13.52
1.199	2.328	2.917	2.118	1.628	0.035	16.08
				1.944	0.040	18.41
				2.349	0.044	21.30
				2.804	0.046	24.13
1.198	2.328	3.100	1.200	1.641	0.034	15.90
				1.972	0.036	18.05
				2.323	0.040	20.31
				2.797	0.042	22.93
1.200	2.328	3.018	0.579	1.483	0.036	15.88
				1.629	0.034	15.87
				2.001	0.037	18.08
				2.292	0.039	19.86
				2.571	0.040	21.43
1.699	2.328	2.917	2.618	2.016	0.083	27.31
				2.158	0.078	27.28
				2.217	0.079	27.83

Width of model approach channel (W) = 2.74 ft.
Model layout is shown on page 44.

Tennessee Valley Authority

Fort Patrick Henry Project

Tainter Gates Partially Opened

Gate Trunnion at Various Locations

MODEL TEST DATA

b ft.	L ft.	Trunnion Locations x ft.	Trunnion Locations y ft.	D ft.	h ft.	Q cfs
0.200	2.333	3.115	1.451	0.415	0.001	1.557
				1.081	0.001	2.723
				1.882	0.002	3.677
				3.083	0.002	4.760
0.200	2.333	3.456	0.578	0.471	0.001	1.594
				1.164	0.001	2.630
				1.905	0.001	3.417
				2.679	0.001	4.084
0.198	2.333	3.437	-0.357	0.497	0.001	1.587
				0.923	0.001	2.201
				1.692	0.001	3.010
				2.584	0.001	3.737
0.194	2.333	3.224	-0.946	0.379	0.001	1.745
				0.620	0.001	1.733
				1.002	0.001	2.201
				1.550	0.001	2.727
				2.047	0.001	3.150
0.697	2.333	3.222	-1.940	1.372	0.015	9.915
				1.947	0.018	12.53
				2.472	0.019	14.44
				3.039	0.019	16.29
0.700	2.333	3.563	1.067	1.382	0.014	9.453
				1.976	0.016	11.74
				2.462	0.016	13.39
				2.983	0.017	14.93
0.697	2.333	3.544	0.132	1.086	0.016	9.420
				1.467	0.013	9.439
				1.940	0.014	11.09
				2.459	0.015	12.60
				2.972	0.015	14.07
0.701	2.333	3.331	-0.457	1.345	0.013	8.977
				1.739	0.014	10.31
				2.232	0.014	11.86
				2.497	0.014	12.57

Width of model approach channel (W) = 2.74 ft.
Model layout is shown on page 44.

Tennessee Valley Authority

Fort Patrick Henry Project

Tainter Gates Partially Opened

Gate Trunnion at Various Locations

MODEL TEST DATA

b	L	Trunnion Locations x	Trunnion Locations y	D	h	Q
ft.	ft.	ft.	ft.	ft.	ft.	cfs
1.200	2.333	3.329	2.428	1.886	0.048	20.08
				2.113	0.050	21.53
				2.332	0.052	23.08
				2.666	0.054	25.26
1.198	2.333	3.670	1.555	1.863	0.045	19.30
				2.134	0.046	20.66
				2.402	0.047	22.31
				2.784	0.048	24.40
1.199	2.333	3.651	0.620	1.881	0.043	18.94
				2.192	0.043	20.46
				2.514	0.044	22.19
				2.816	0.045	23.85
1.201	2.333	3.438	0.031	1.698	0.053	20.27
				2.010	0.043	19.44
				2.234	0.043	20.61
				2.548	0.043	22.13
				2.837	0.043	23.40
1.990	2.335	3.670	1.004	0.441	0.001	1.877
				0.442	0.001	2.247
				0.949	0.001	2.695
				1.779	0.002	3.678
				2.959	0.002	4.741
0.199	2.335	3.872	0.090	0.512	0.001	1.880
				1.156	0.001	2.735
				2.046	0.001	3.614
				2.860	0.001	4.279
0.198	2.335	3.709	-0.832	0.443	0.001	1.705
				0.834	0.001	2.233
				1.289	0.001	2.726
				2.138	0.001	3.473
0.701	2.334	3.851	1.470	1.409	0.018	10.65
				1.510	0.018	11.05
				1.795	0.019	12.16
				2.417	0.019	14.41
				2.962	0.019	16.10

Width of model approach channel (W) = 2.74 ft.
Model layout is shown on page 44.

Tennessee Valley Authority

Fort Patrick Henry Project

Tainter Gates Partially Opened

Gate Trunnion at Various Locations

MODEL TEST DATA

b	L	Trunnion Locations x	Trunnion Locations y	D	h	Q
ft.	ft.	ft.	ft.	ft.	ft.	cfs
0.700	2.334	4.053	0.556	1.495	0.015	10.34
				2.064	0.016	12.28
				2.457	0.017	13.45
				2.838	0.017	14.59
0.697	2.334	3.890	-0.366	1.208	0.021	11.16
				1.530	0.014	10.10
				1.911	0.015	11.31
				2.208	0.015	12.06
				2.602	0.015	13.12
1.199	2.334	4.033	1.936	1.825	0.065	22.95
				2.071	0.054	22.37
				2.210	0.055	23.16
				2.404	0.055	24.20
				2.585	0.056	25.33
				2.731	0.056	26.10
1.198	2.334	4.235	1.022	1.924	0.051	21.00
				2.020	0.051	21.22
				2.225	0.050	22.02
				2.467	0.050	23.22
				2.704	0.050	24.42
1.199	2.334	4.072	0.100	2.141	0.046	21.14
				2.260	0.048	21.83
				2.577	0.046	23.06
				2.797	0.046	23.94
0.199	2.338	4.101	0.677	0.518	0.001	2.247
				1.082	0.002	3.019
				1.928	0.002	3.914
				2.748	0.002	4.626
0.200	2.338	4.233	-0.250	0.492	0.002	2.673
				0.512	0.001	2.118
				1.293	0.002	3.054
				2.007	0.002	3.692
				2.678	0.002	4.247

Width of model approach channel (W) = 2.74 ft.
Model layout is shown on page 44.

Tennessee Valley Authority

Hales Bar Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.4529	0.595	11.53	0.014	15.74	21.17	82,140	4.04
	0.666	12.52	0.015		23.67	89,190	4.00
	0.869	15.01	0.018		30.83	106,900	3.96
	0.527	10.81	0.014		18.81	77,010	4.21
	0.561	11.17	0.014		19.99	79,570	4.11
	0.526	10.84	0.014		18.77	77,220	4.23
	0.612	11.74	0.014		21.76	83,630	4.02
	0.548	11.02	0.014		19.54	78,500	4.14
	0.588	11.55	0.014		20.93	82,280	4.08
	0.565	11.18	0.014		20.13	79,640	4.09
	0.669	12.59	0.016		23.81	89,700	4.01
	0.628	11.97	0.015		22.35	85,270	4.01
	0.712	13.10	0.016		25.31	93,320	3.98
	0.751	13.59	0.016		26.66	96,810	3.97
0.3991	0.588	10.18	0.011	13.87	20.82	72,520	3.94
	0.558	9.824	0.011		19.78	69,980	3.96
	0.517	9.346	0.010		18.32	66,580	4.02
	0.486	8.994	0.010		17.24	64,070	4.08
	0.475	8.946	0.010		16.86	63,730	4.14
0.3438	0.604	9.169	0.009	11.95	21.31	65,320	3.90
	0.562	8.706	0.008		19.81	62,020	3.90
	0.518	8.191	0.008		18.28	58,350	3.90
	0.457	7.560	0.007		16.13	53,850	3.99
	0.430	7.269	0.007		15.19	51,780	4.04
	0.414	7.135	0.007		14.63	50,830	4.10
	0.422	7.235	0.007		14.91	51,540	4.09
0.2894	0.483	6.723	0.006	10.06	17.00	47,890	3.85
	0.605	7.928	0.007		21.27	56,480	3.88
	0.403	5.938	0.005		14.18	42,300	3.91
	0.493	6.809	0.006		17.35	48,500	3.84
	0.419	6.049	0.005		14.74	43,090	3.86
	0.592	7.776	0.007		20.82	55,390	3.86

Tennessee Valley Authority

Hales Bar Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.1818	0.354	3.650	0.002	6.319	12.37	26,000	3.78
	0.547	4.915	0.003		19.12	35,010	3.86
	0.462	4.393	0.002		16.13	31,290	3.83
	0.413	4.096	0.002		14.43	29,180	3.83
	0.488	4.574	0.003		17.07	32,580	3.85
	0.580	5.095	0.003		20.27	36,290	3.86
	0.559	4.972	0.003		19.54	35,420	3.85
0.2342	0.410	5.019	0.003	8.141	14.36	35,750	3.83
	0.368	4.636	0.003		12.90	33,020	3.83
	0.450	5.354	0.004		15.78	38,140	3.82
	0.590	6.461	0.004		20.65	46,030	3.86
0.1251	0.601	3.719	0.002	4.348	20.96	26,490	3.91
	0.512	3.382	0.001		17.83	24,090	3.89
	0.422	3.034	0.001		14.70	21,610	3.90
	0.348	2.693	0.001		12.13	19,180	3.89
	0.466	3.215	0.001		16.23	22,900	3.90
0.0720	0.475	2.039	0.000	2.503	16.51	14,530	4.12
	0.555	2.216	0.001		19.33	15,790	4.12
	0.596	2.330	0.001		20.75	16,600	4.17
	0.518	2.153	0.001		18.04	15,340	4.16
	0.365	1.762	0.000		12.69	12,550	4.12

Tennessee Valley Authority

Hales Bar Project

Tainter Gates Raised Above the Water Surface

MODEL TEST DATA			EQUIVALENT PROTOTYPE		
D ft.	Q cfs	h ft.	H ft.	Q cfs	C
0.896	27.80	0.058	33.16	198,000	4.32
0.851	25.43	0.051	31.35	181,100	4.30
0.817	23.66	0.046	30.00	168,500	4.27
0.775	21.62	0.040	28.33	154,000	4.26
0.731	19.44	0.034	26.59	138,500	4.21
0.684	17.26	0.028	24.75	122,900	4.16
0.579	12.93	0.018	20.75	92,100	4.06
0.537	11.24	0.015	19.19	80,060	3.97
0.617	14.47	0.022	22.21	103,100	4.10
0.483	9.387	0.011	17.17	66,870	3.92
0.430	7.647	0.008	15.22	54,470	3.82
0.372	5.957	0.005	13.10	42,400	3.72
0.306	4.321	0.003	10.74	30,780	3.64
0.242	2.919	0.002	8.48	20,790	3.51
0.654	15.88	0.025	23.60	113,100	4.11
0.568	12.39	0.017	20.33	88,260	4.01

Tennessee Valley Authority

Hiwassee Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.0213	0.280	0.3292	Negligible	1.17	15.40	7,385	4.96
	0.185	0.2692			10.18	6,039	5.03
	0.070	0.1636			3.85	3,670	5.24
	0.310	0.3456			~~1.71~~ 17.05	7,753	4.96
	0.449	0.4161			24.70	9,335	4.92
	0.385	0.3849			21.18	8,635	4.92
	0.048	0.1296			2.64	2,907	5.25
	0.051	0.1372			2.80	3,078	5.38
	0.052	0.1415			2.86	3.174	5.46
	0.051	0.1404			2.80	3,150	5.51
	0.056	0.1520			3.08	3,410	5.61
	0.063	0.1568			3.46	3,518	5.37
	0.077	0.1725			4.24	3,870	5.20
	0.084	0.1812			4.62	4,065	5.27
	0.124	0.2188			6.82	4,909	5.15
	0.229	0.3010			12.60	6,753	5.06
	0.322	0.3555			17.71	7,975	5.01
0.0421	0.142	0.3687		2.32	7.81	8,271	4.16
	0.100	0.3133			5.50	7,029	4.39
	0.196	0.4123			10.78	9,250	3.86
	0.277	0.5273			15.24	11,830	4.08
	0.385	0.6276			21.18	14,080	4.08
	0.473	0.6983			26.02	15,670	4.08
	0.203	0.4465			11.16	10,020	4.10
0.0767	0.120	0.5475		4.22	6.60	12,280	4.13
	0.188	0.6886			10.34	15,450	3.82
	0.261	0.8201			14.36	18,400	3.72
	0.318	0.9188			17.49	20,610	3.72
	0.374	1.003			20.57	22,500	3.71
	0.440	1.094			24.20	24,540	3.69
0.0762	0.172	0.6546		4.19	9.46	14,690	3.88
	0.203	0.7079			11.16	15,880	3.78

Tennessee Valley Authority

Hiwassee Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.1302	0.229	1.222	Negligible	7.16	12.60	27,410	3.85
	0.277	1.344			15.24	30,150	3.71
	0.389	1.612			21.40	36,160	3.59
	0.447	1.751			24.59	39,280	3.59
	0.483	1.833			26.57	41,120	3.59
	0.425	1.703			23.38	38,210	3.60
	0.346	1.512			19.03	33,920	3.62
0.1293	0.300	1.382		7.11	16.50	31,000	3.65
	0.347	1.505			19.08	33,760	3.62
	0.477	1.817			26.24	40,760	3.62
	0.237	1.229			13.04	27,570	3.80
	0.248	1.255			13.64	28,150	3.76
0.187	0.402	2.282		10.28	22.11	51,190	3.63
	0.350	2.130			19.25	47,780	3.72
	0.320	2.057			17.60	46,150	3.83
	0.452	2.438			24.86	54,690	3.59
	0.491	2.563			27.00	57,500	3.59
0.186	0.317	2.041		10.23	17.44	45,790	3.84
	0.320	2.037			17.60	45,700	3.81
0.238	0.445	3.051		13.09	24.48	68,450	3.72
	0.491	3.213			27.00	72,080	3.66
	0.381	2.908			20.96	65,240	3.96
	0.388	2.909			21.34	65,260	4.04
0.294	0.501	4.033		16.17	27.56	90,480	3.82
	0.422	3.993			23.21	89,580	4.32
	0.422	3.989			23.21	89,490	4.31
	0.460	3.989			25.30	89,490	4.03
	0.465	3.989			25.58	89,490	4.00

Tennessee Valley Authority

Hiwassee Project

Tainter Gates Raised Above Water Surface

MODEL TEST DATA			EQUIVALENT PROTOTYPE		
D ft.	Q cfs	h ft.	H ft.	Q cfs	C
0.199	1.224		10.94	27,460	3.40
0.238	1.616		13.09	36,250	3.44
0.303	2.348		16.66	52,680	3.48
0.353	3.002		19.42	67,350	3.54
0.463	4.673		25.46	104,800	3.66
0.083	0.3053		4.56	6,849	3.15
0.081	0.2932		4.46	6,578	3.13
0.150	0.7790		8.25	17,480	3.31
0.113	0.4982		6.22	11,180	3.24
0.147	0.7553		8.08	16,940	3.31
0.157	0.8340		8.64	18,710	3.31
0.217	1.404		11.94	31,500	3.43
0.252	1.769	Negligible	13.86	39,690	3.45
0.283	2.116		15.56	47,470	3.47
0.293	2.244		16.12	50,340	3.49
0.319	2.548		17.54	57,160	3.49
0.371	3.254		20.40	73,000	3.56
0.289	2.200		15.90	49,350	3.50
0.498	5.274		27.39	118,300	3.71
0.314	2.498		17.27	56,040	3.50
0.426	4.059		23.43	91,060	3.60
0.054	0.1572		2.97	3,527	3.11
0.120	0.5475		6.60	12,280	3.25
0.347	2.893		19.08	64,900	3.49
0.347	2.911		19.08	65,310	3.52
0.422	3.993		23.21	89,580	3.60
0.280	2.082		15.40	46,710	3.47
0.048	0.1296		2.64	2,907	3.05
0.081	0.2886		4.46	6,474	3.08

Tennessee Valley Authority

Watts Bar Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.052	0.168	0.803	0.000	1.82	5.88	5,819	3.99
	0.301	1.119	0.000		10.54	8,110	3.99
	0.463	1.411	0.000		16.20	10,230	3.99
	0.650	1.695	0.000		22.75	12,280	4.01
	0.831	1.932	0.000		29.08	14,000	4.03
	1.068	2,198	0.000		37.38	15,930	4.02
~~0.078~~	0.100	0.719	0.000	~~2.73~~	3.50	5,211	3.31+ ~~3.70~~* [4.96]
[0.078]	1.023	3.024	0.000	[2.73]	35.80	21,920	3.79
	0.608	2.278	0.000		21.28	16,510	3.76
	0.856	2.746	0.000		29.96	19,900	3.78
	0.451	1.932	0.000		15.78	14,000	3.75
	0.165	1.072	0.000		5.78	7,769	3.78
	0.299 [0.127]	1.523 [1.025]	0.000 [0.000]		10.46 [4.44]	11,040 [7,428]	3.72+ [3.30+ 4.34*]
0.111	0.346	2.196	0.000	3.88	12.11	15,910	3.57
	0.576	2.962	0.000		20.16	21,470	3.59
	0.842	3.703	0.001		29.50	26,840	3.65
	1.074	4.161	0.001		37.62	30,160	3.61
	1.056	4.140	0.001		37.00	30,000	3.62
	~~0.183~~ [1.044]	~~1.803~~ [4.149]	0.000[1]		36.~~46~~[58]	~~13,070~~ [30,070]	~~3.35+~~ [3.65]
~~0.166~~	~~1.044~~	~~4.149~~	~~0.001~~	~~5.81~~	~~36.58~~	~~30,070~~	~~3.65~~
[0.166]	0.271	2.679	0.001	[5.81]	9.52	19,420	3.63
	1.068	6.182	0.001		37.42	44,800	3.64
	0.837	5.417	0.001		29.33	39,260	3.65
	0.616	4.552	0.001		21.60	32,990	3.65
	0.441	3.688	0.001		15.47	26,730	3.61
0.223	0.280	3.538	0.001	7.80	9.84	25,640	3.46+ 3.82*
	0.356	4.102	0.001		12.50	29,730	3.64
	0.540	5.436	0.002		18.97	39,400	3.62
	0.702	6.396	0.002		24.64	46,350	3.62
	0.858	7.189	0.002		30.10	52,100	3.62
	1.064	8.186	0.002		37.31	59,330	3.65

+Gate lip touching nappe C from Equation B.
*Gate lip touching nappe C from Equation A.

Tennessee Valley Authority

Watts Bar Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.338	1.061	11.98	0.005	11.83	37.28	86,820	3.64
	0.854	10.49	0.005		30.06	76,020	3.64
	0.663	8.894	0.004		23.34	64,460	3.64
	0.484	7.141	0.003		17.04	51,750	3.68
	0.420	6.781	0.003		14.81	49,140	3.59+
							3.95*
	0.476	7.102	0.003		16.76	51,470	3.70
	1.050	11.94	0.005		36.92	86,530	3.65
0.453	0.616	10.82	0.006	15.86	21.77	78,410	3.74
	0.565	10.85	0.007		20.02	78,630	3.65+
							4.04*
	0.679	11.48	0.007		24.01	83,200	3.67
	0.840	13.33	0.008		29.68	96,600	3.65
	1.047	15.50	0.009		36.96	112,300	3.66
0.567	0.688	15.07	0.012	19.84	24.50	109,200	3.75+
							4.09*
	0.765	15.39	0.011		27.16	111,500	3.81
	0.854	16.46	0.012		30.31	119,300	3.73
	0.957	17.72	0.013		33.95	128,400	3.69
	1.035	18.60	0.013		36.68	134,800	3.67
0.681	0.833	20.71	0.019	23.83	29.82	150,100	3.84+
							4.21*
	0.937	20.81	0.018		33.42	150,800	3.84
	1.007	21.82	0.018		35.88	158,100	3.80
	1.048	22.36	0.019		37.34	162,000	3.78
	0.928	20.69	0.018		33.11	149,900	3.85

*Gate lip touching nappe C from Equation A.
+Gate lip touching nappe C from Equation B.

Tennessee Valley Authority

Watts Bar Project

Tainter Gates Raised Above Water Surface

MODEL TEST DATA			EQUIVALENT PROTOTYPE		
D	Q	h	H	Q	C
ft.	cfs	ft.	ft.	cfs	
0.100	0.717	0.000	3.50	5,211	3.31
0.183	1.803	0.000	6.40	13,070	3.35
0.280	3.538	0.001	9.84	25,640	3.46
0.420	6.781	0.003	14.80	49,140	3.59
0.565	10.85	0.007	20.02	78,630	3.65
0.688	15.07	0.012	24.50	109,200	3.75
0.833	20.71	0.019	29.82	150,100	3.84
0.920	24.51	0.025	33.08	177,600	3.89
0.561	10.73	0.007	19.88	77,760	3.65
0.703	15.63	0.012	25.02	113,300	3.77
0.127	10.24	0.000	4.44	7,421	3.30
0.900	23.64	0.024	32.34	171,300	3.88
0.699	15.34	0.012	24.88	111,200	3.73
0.498	8.833	0.005	17.61	64,010	3.61
0.080	0.527	0.000	2.82	3,819	3.40

Tennessee Valley Authority

Wheeler Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G. O. ft.	H ft.	Q cfs	C
0.0286	0.096	0.3164	0.000	0.98	3.30	2,188	3.71
	0.131	0.3794	0.000		4.50	2,624	3.72
	0.240	0.5280	0.000		8.24	3,651	3.71
	0.279	0.5704	0.000		9.58	3,945	3.70
	0.417	0.6987	0.000		14.32	4,832	3.68
	0.344	0.6346	0.000		11.82	4,389	3.70
	0.184	0.4629	0.000		6.32	3,201	3.74
	0.508	0.7730	0.000		17.45	5,346	3.66
0.0575	0.160	0.7723	0.000	1.98	5.50	5,341	3.54
	0.197	0.8797	0.000		6.77	6,083	3.56
	0.114	0.6192	0.000		3.92	4,282	3.53
	0.251	1.015	0.000		8.62	7,019	3.57
	0.294	1.112	0.000		10.10	7,690	3.59
	0.355	1.235	0.000		12.19	8,541	3.59
	0.412	1.338	0.000		14.15	9,253	3.58
	0.497	1.480	0.000		17.07	10,230	3.59
0.0875	0.116	0.8990	0.000	3.00	3.98	6,220	3.26+ 3.71*
	0.151	1.061	0.000		5.19	7,340	3.56
	0.195	1.273	0.000		6.70	8,803	3.58
	0.229	1.416	0.000		7.87	9,792	3.59
	0.269	1.568	0.000		9.24	10,840	3.61
	0.310	1.706	0.000		10.65	11,800	3.61
	0.379	1.922	0.000		13.02	13,290	3.63
	0.447	2.116	0.000		15.35	14,630	3.64
	0.478	2.196	0.000		16.42	15,190	3.64
	0.504	2.261	0.000		17.31	15,640	3.64
0.1166	0.151	1.385	0.000	4.00	5.19	9,578	3.38+ 3.79*
	0.186	1.560	0.000		6.39	10,790	3.61
	0.228	1.796	0.000		7.83	12,420	3.59
	0.283	2.080	0.000		9.72	14,380	3.60
	0.334	2.320	0.001		11.51	16,040	3.62
	0.396	2.576	0.001		13.64	17,810	3.63
	0.454	2.793	0.001		15.63	19,310	3.64
	0.512	2.997	0.001		17.62	20,730	3.64
	0.511	2.990	0.001		17.59	20,680	3.64

*Gate lip touching nappe C from Equation A.
+Gate lip touching nappe C from Equation B.

Tennessee Valley Authority

Wheeler Project

Tainter Gates Partially Opened

MODEL TEST DATA				EQUIVALENT PROTOTYPE			
G.O. ft.	D ft.	Q cfs	h ft.	G.O. ft.	H ft.	Q cfs	C
0.2037	0.258	3.299	0.001	7.00	8.90	22,810	3.58+ 3.98*
	0.276	3.358	0.001		9.51	23,220	3.82
	0.288	3.467	0.001		9.93	23,980	3.80
	0.322	3.684	0.001		11.10	25,480	3.70
	0.365	4.007	0.002		12.61	27,710	3.67
	0.418	4.430	0.002		14.43	30,640	3.70
	0.456	4.677	0.002		15.73	32,340	3.68
	0.497	4.945	0.002		17.14	34,200	3.69
	0.421	4.434	0.002		14.53	30,660	3.68
0.2912	0.365	5.866	0.003	10.00	12.64	40,570	3.76+ 4.16*
	0.404	5.977	0.003		13.98	41,330	3.88
	0.418	6.081	0.003		14.46	42,050	3.85
	0.436	6.243	0.003		15.08	43,170	3.82
	0.461	6.502	0.004		15.97	44,960	3.81
	0.500	6.841	0.004		17.31	47,310	3.77

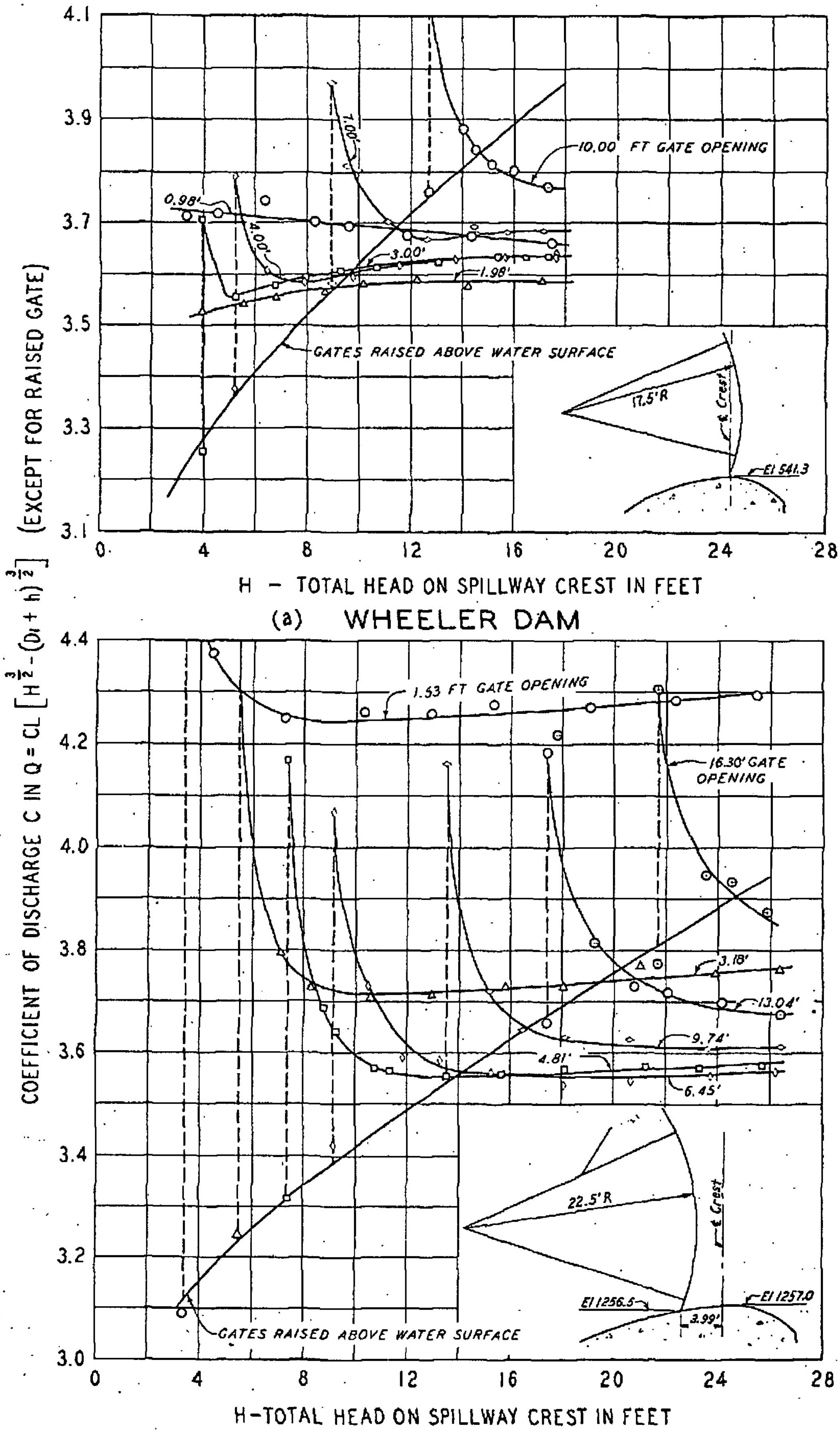
*Gate lip touching nappe C from Equation A.
+Gate lip touching nappe C from Equation B.

Tennessee Valley Authority

Wheeler Project

Tainter Gates Raised Above Water Surface

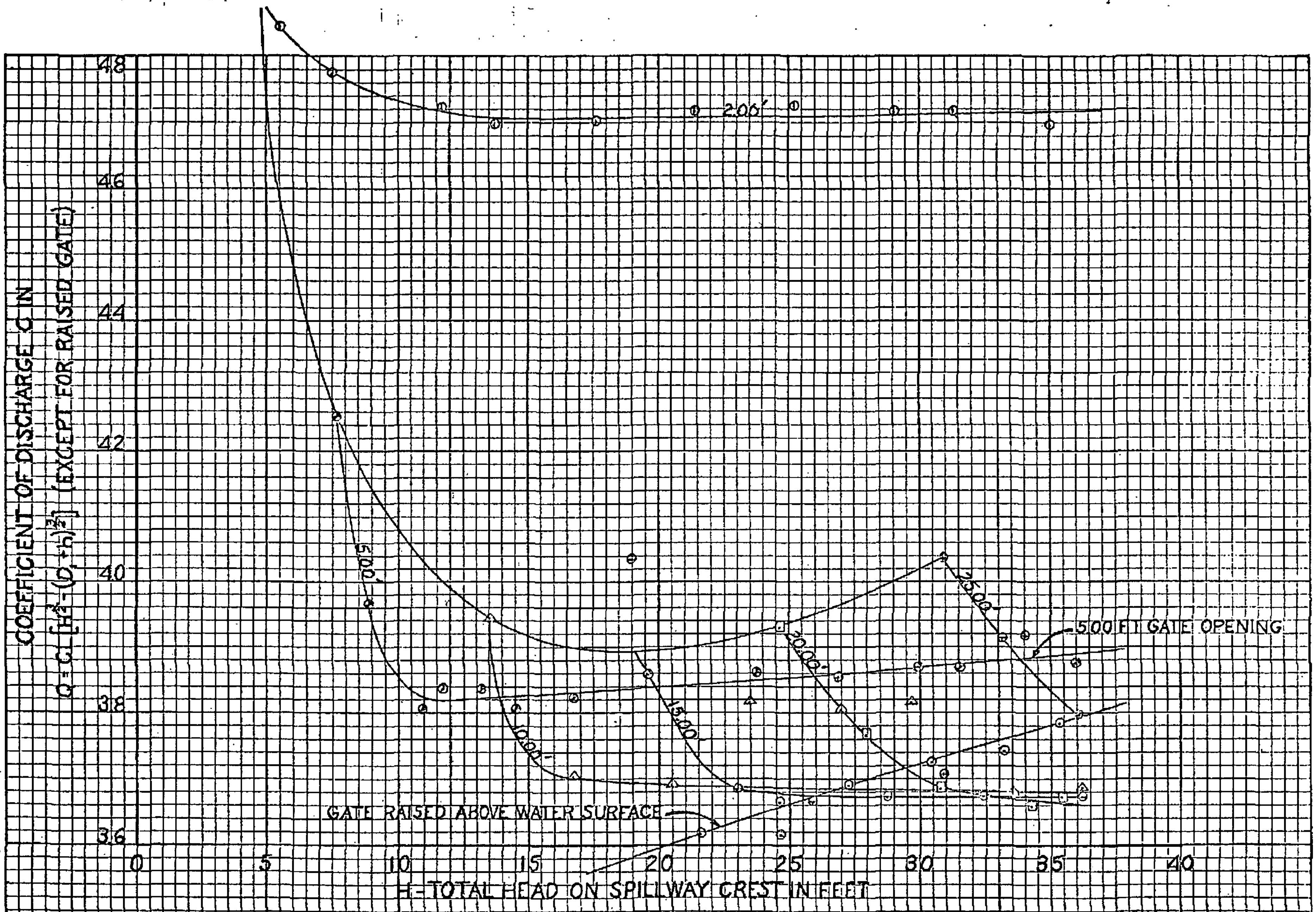
MODEL TEST DATA			EQUIVALENT PROTOTYPE		
D ft.	Q cfs	h ft.	H ft.	Q cfs	C
0.178	1.786	0.000	6.11	12,350	3.41
0.214	2.444	0.001	7.39	16,900	3.51
0.281	3.788	0.002	9.72	26,200	3.60
0.307	4.386	0.002	10.58	30,330	3.67
0.347	5,348	0.003	12.02	36,980	3.70
0.390	6.559	0.004	13.53	45,360	3.80
0.440	8,038	0.006	15.32	55,590	3.86
0.405	6.998	0.004	14.05	48,400	3.83
0.366	5.892	0.003	12.68	40,750	3.76
0.191	1.996	0.000	6.56	13,800	3.42
0.218	2.490	0.001	7.52	17,220	3.48
0.279	3.742	0.002	9.65	25,880	3.60
0.306	4.366	0.002	10.58	30,190	3.66
0.416	7.316	0.005	14.46	50,590	3.83
0.465	8.775	0.006	16.18	60,680	3.89
0.499	9.914	0.009	17.45	68,560	3.92
0.305	4.314	0.002	10.55	29,830	3.63
0.076	0.464	0.000	2.61	3,209	3.16
0.123	1.004	0.000	4.23	6,943	3.34
0.155	1.444	0.000	5.32	9,986	3.39
0.116	0.8990	0.000	3.98	6,220	3.26
0.151	1.385	0.000	5.19	9,578	3.38
0.258	3.299	0.001	8.90	22,810	3.58
0.365	5.866	0.003	12.64	40,570	3.76



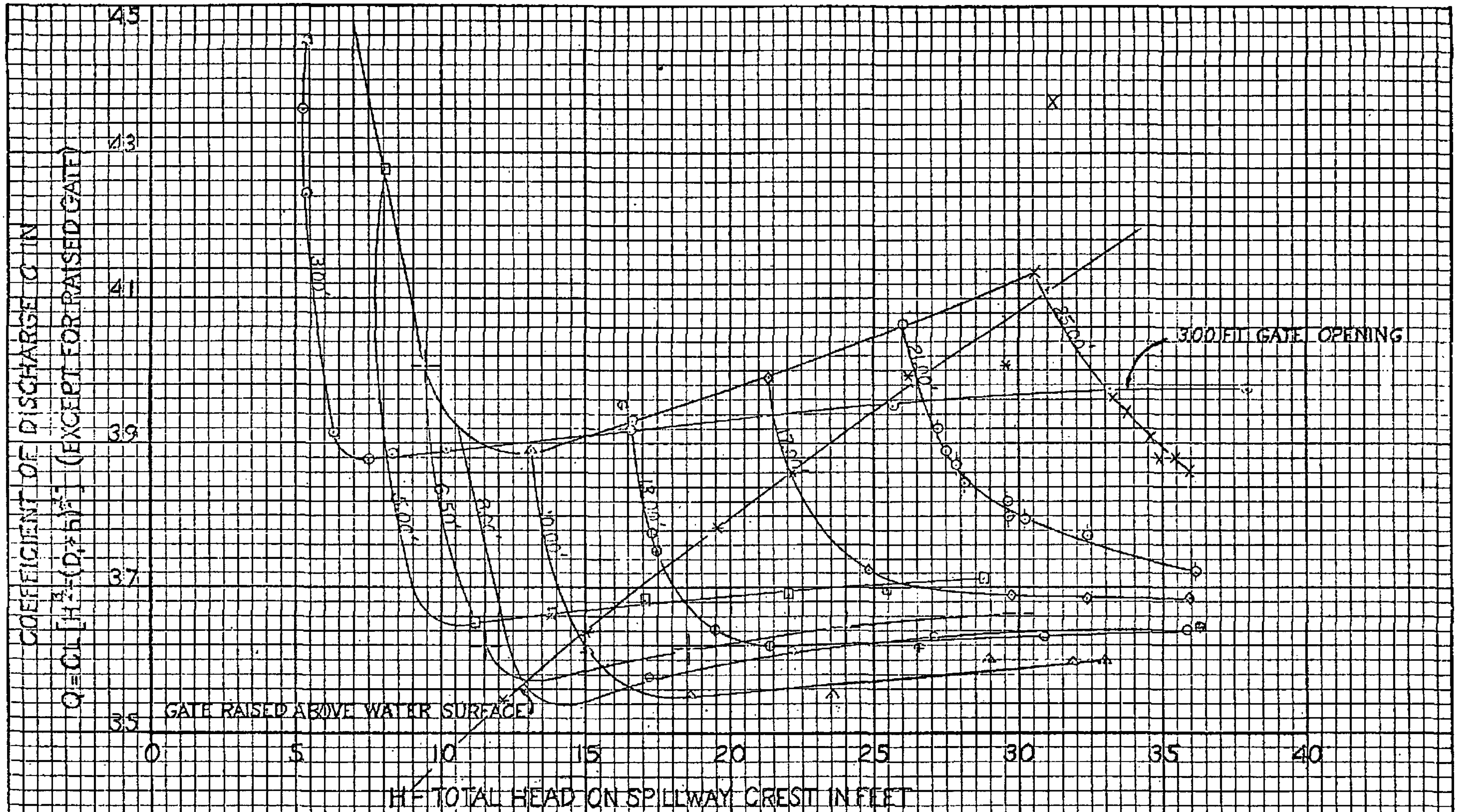
(a) WHEELER DAM

(b) APALACHIA DAM

TAINTER GATE SPILLWAY DISCHARGE COEFFICIENTS

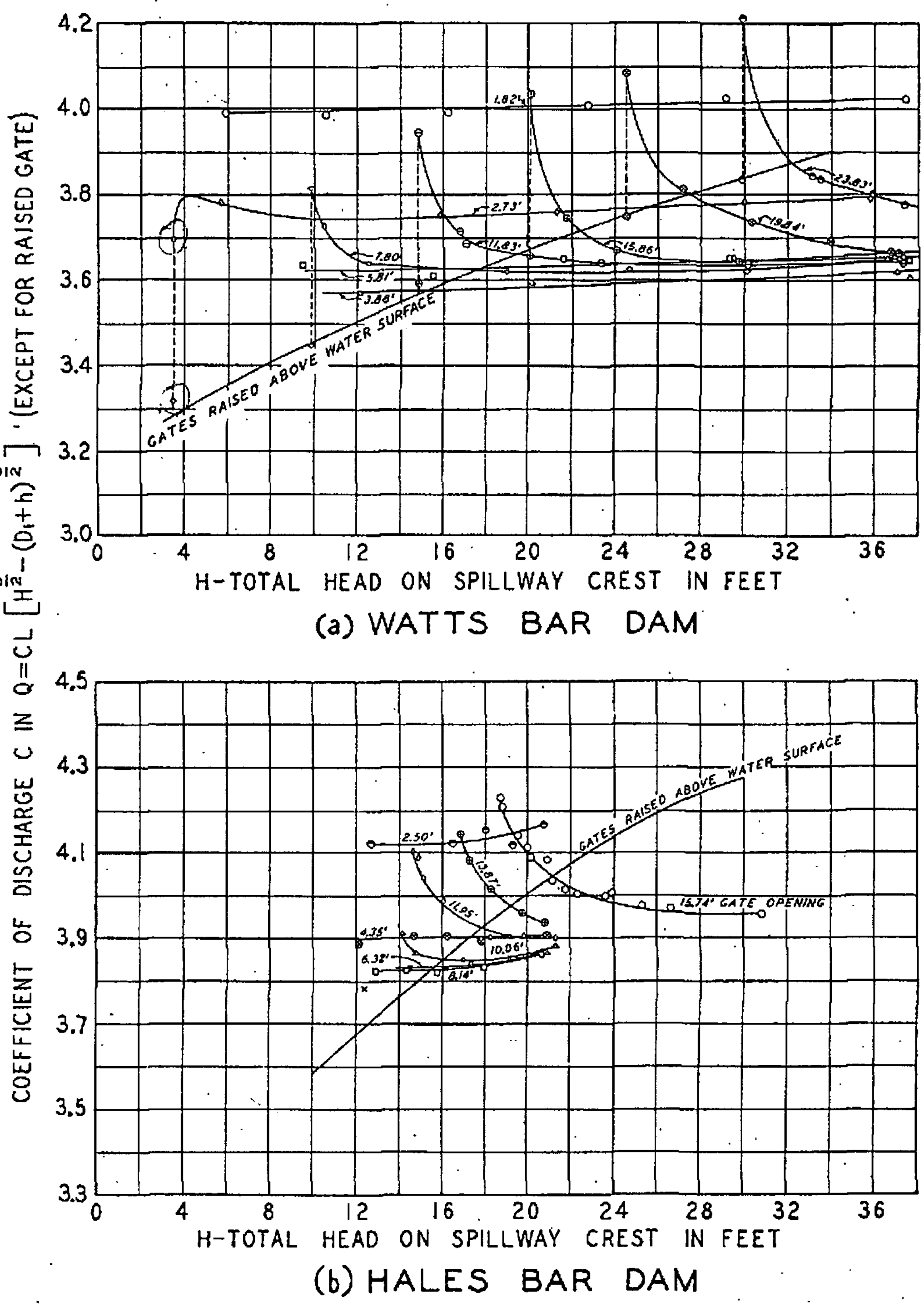


BOONE DAM
TAINTER GATE SPILLWAY DISCHARGE COEFFICIENT

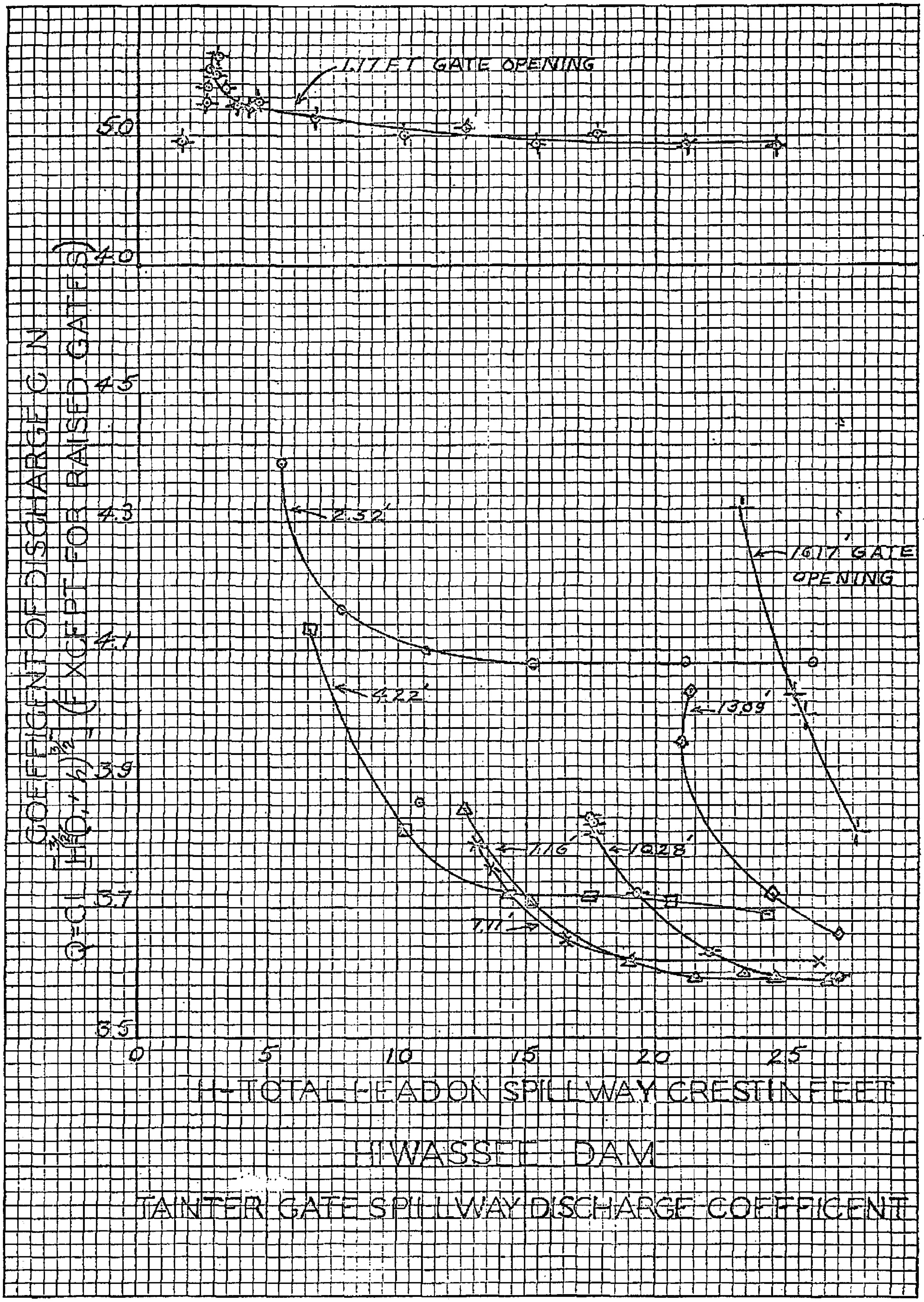


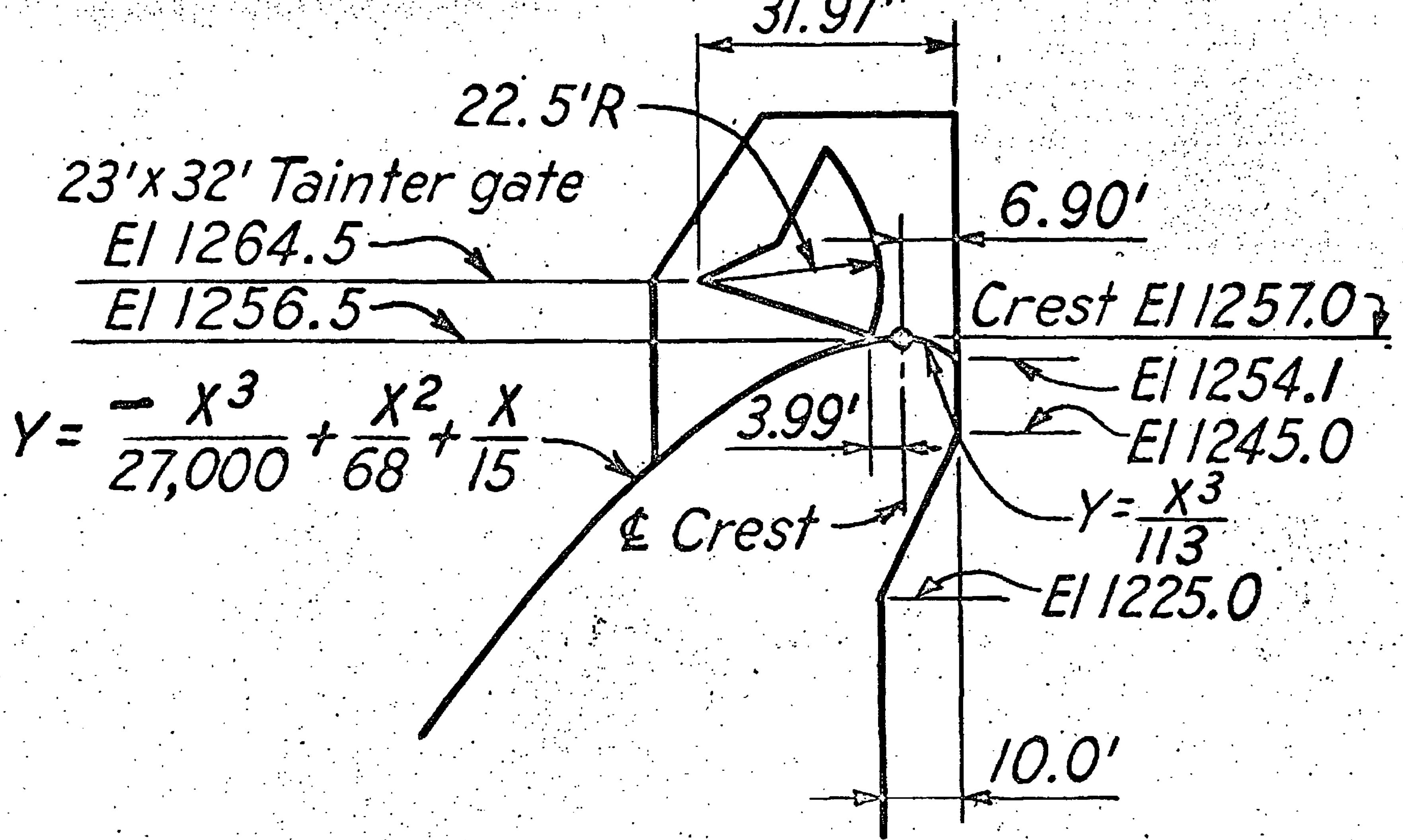
FORT PATRICK HENRY DAM

TAINTER GATE SPILLWAY DISCHARGE COEFFICIENTS

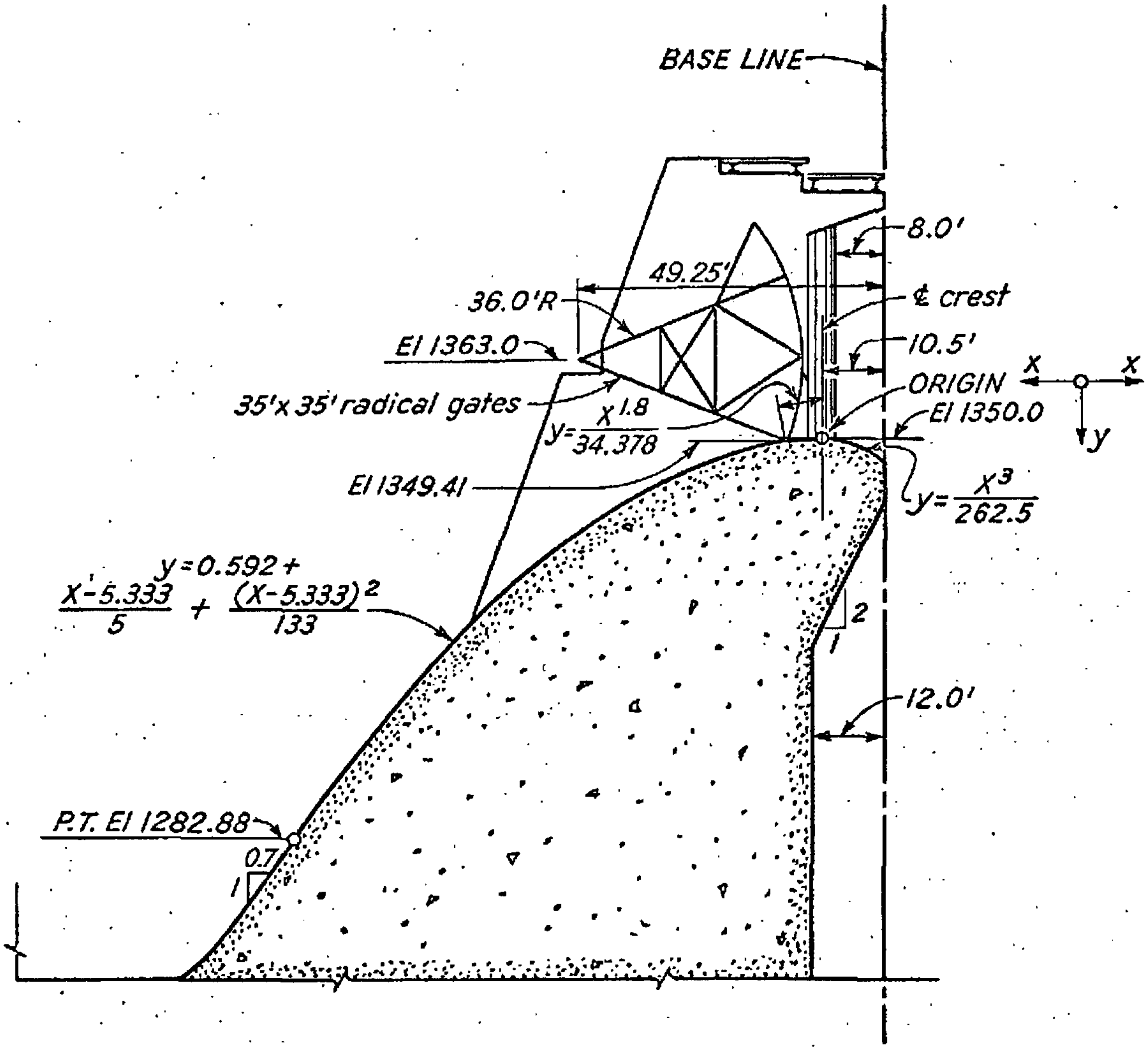


TAINTER GATE SPILLWAY DISCHARGE COEFFICIENTS

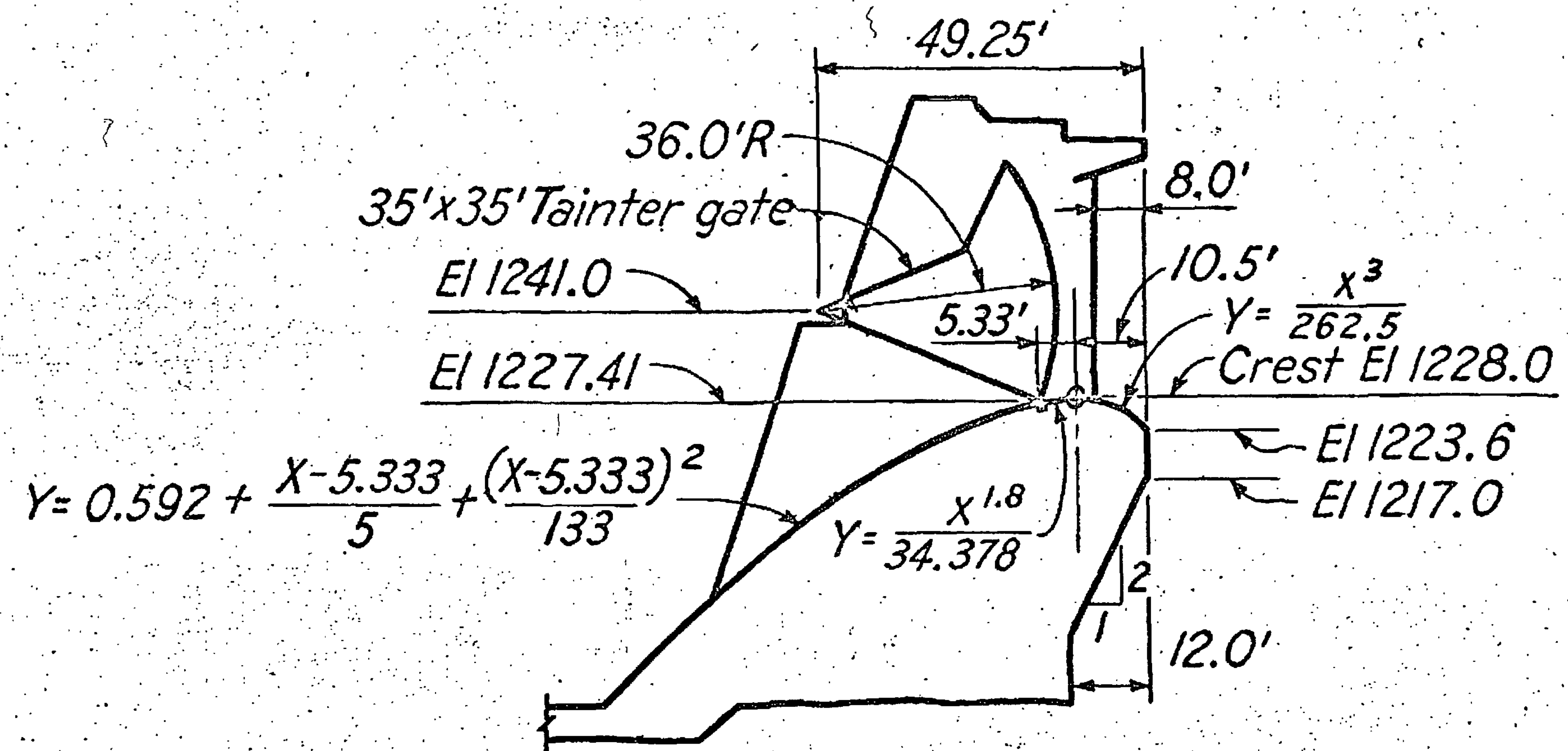

1.17 F.T. GATE OPENING
5.0
4.0
4.5
4.3
4.1
3.9
3.7
3.5
2.32'
16.17' GATE OPENING
4.22'
13.09'
1.16'
10.28'
7.11'
0
5
10
15
20
25
COEFFICENT OF DISCHARGE C IN
Q=CL[H(D,+h)^3/2](EXCEPT FOR RAISED GATES)
H-TOTAL HEAD ON SPILLWAY CREST IN FEET
HIWASSEE DAM
TAINTER GATE SPILLWAY DISCHARGE COEFFICENT



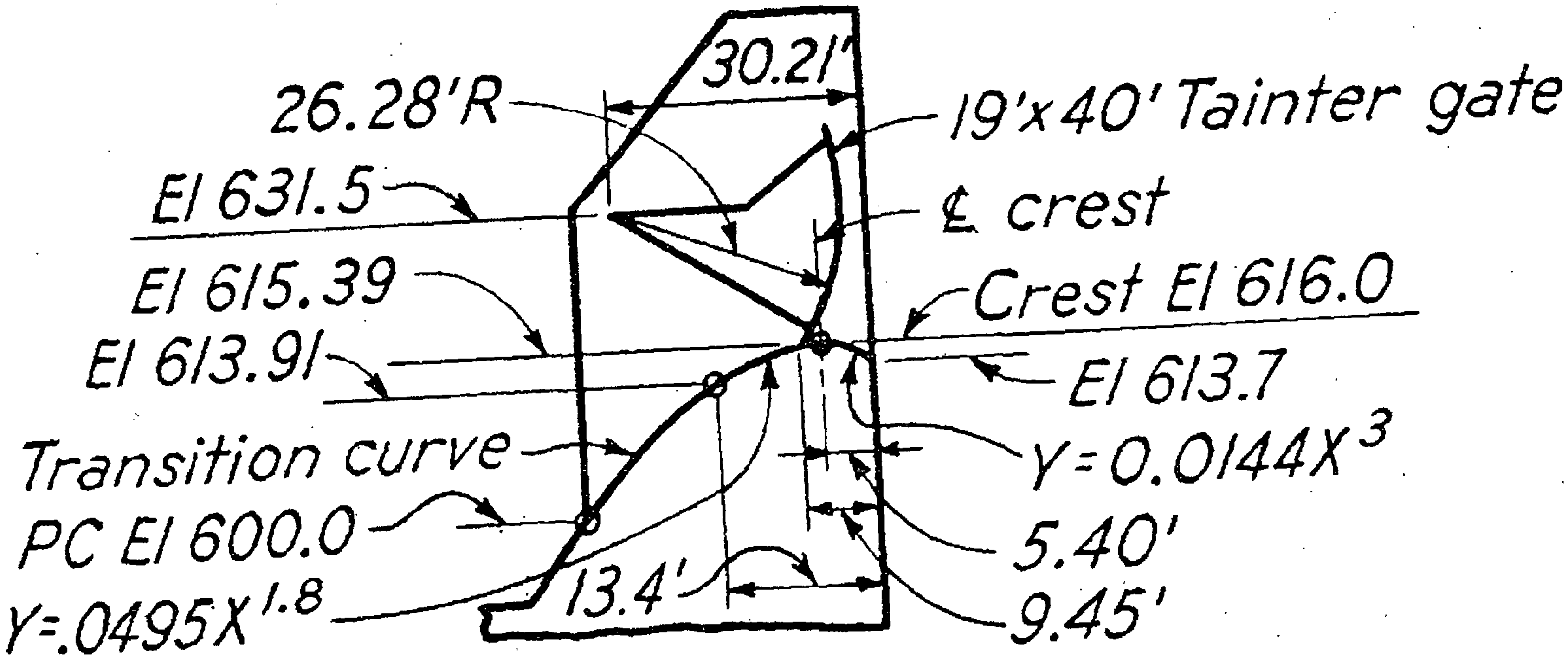
APALACHIA PROJECT



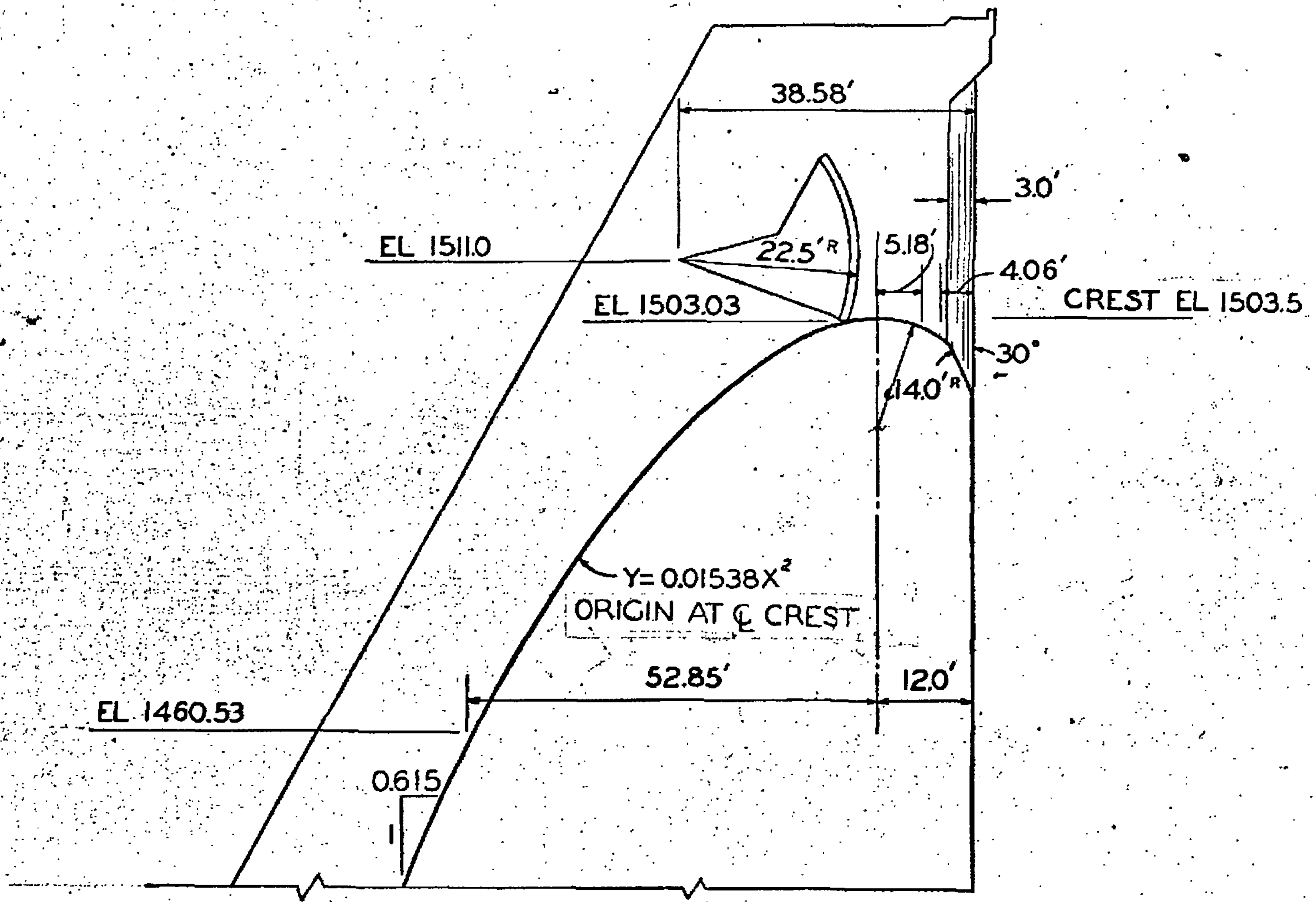
BOONE PROJECT



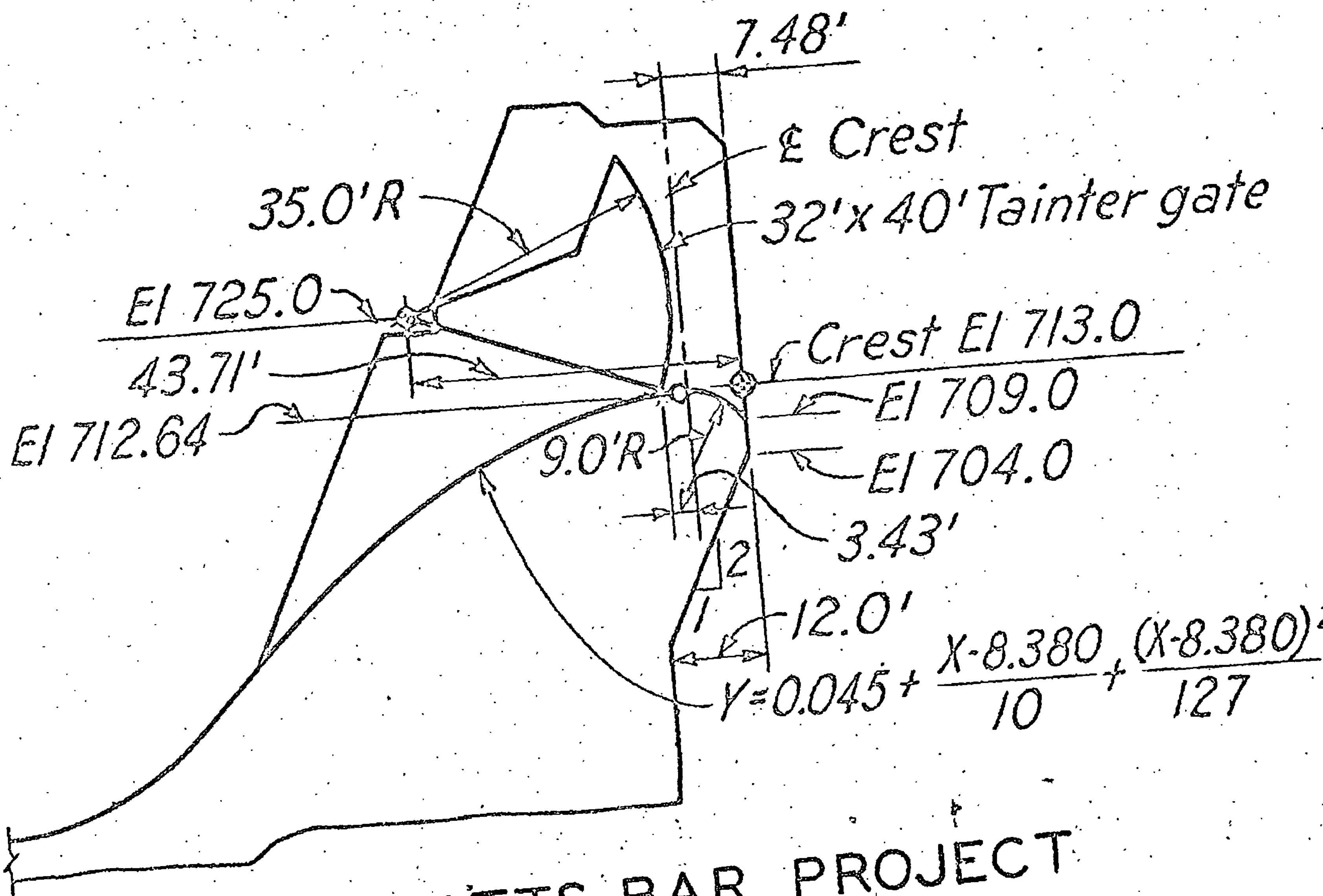
FORT PATRICK HENRY PROJECT



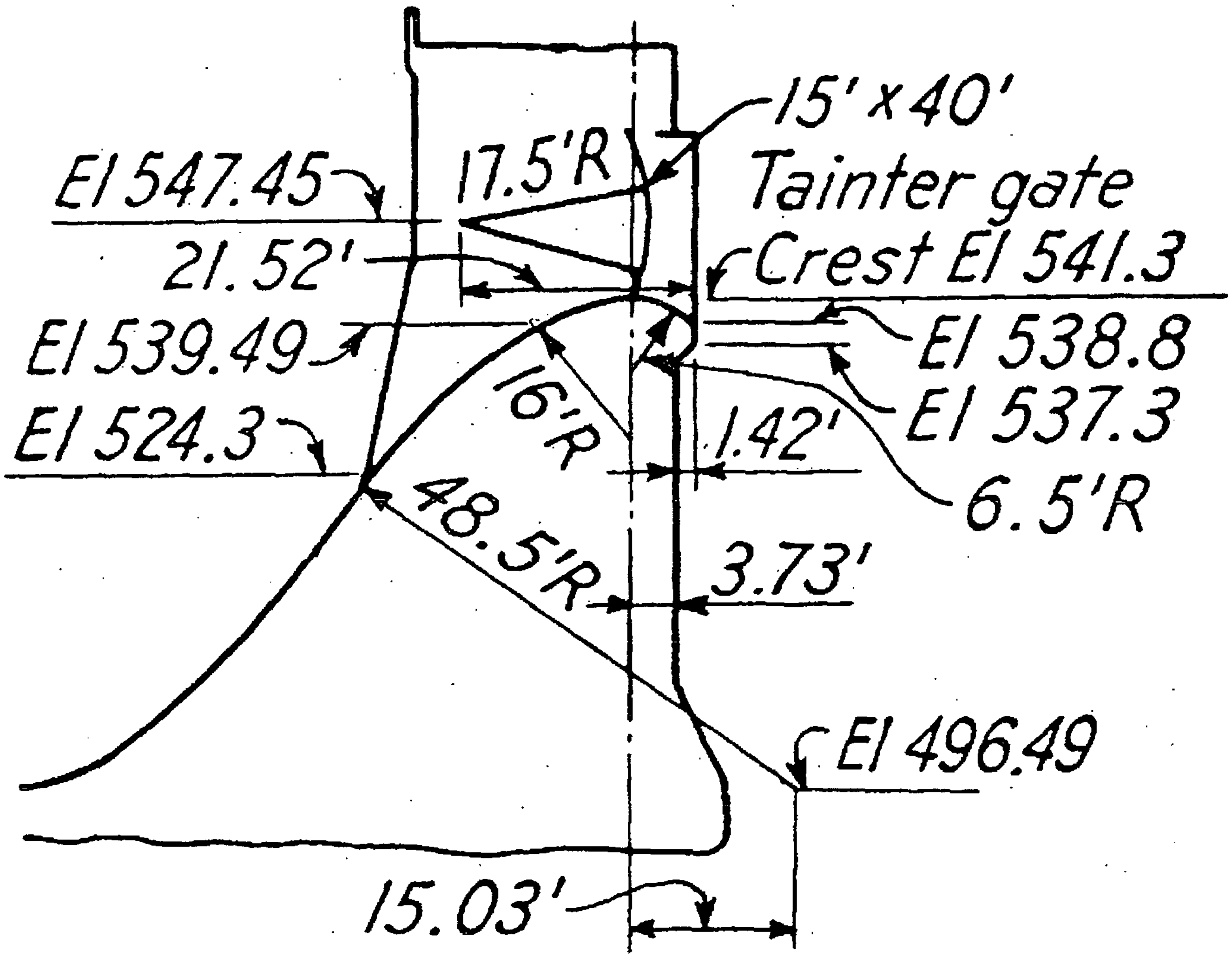
HALES BAR PROJECT



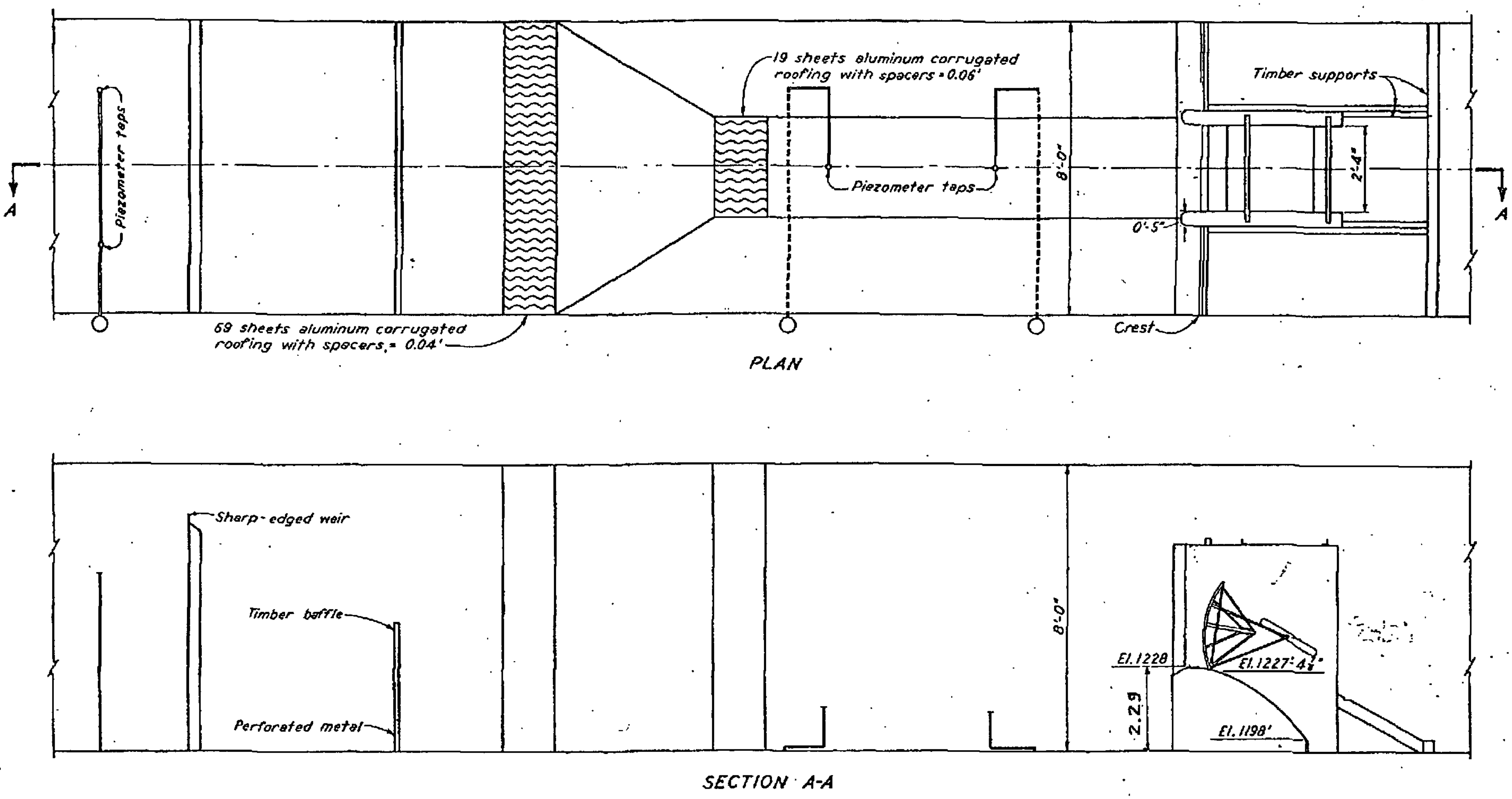
HIWASSEE PROJECT



WATTS BAR PROJECT



WHEELER PROJECT



Scales

Model	0	1	2	3	4	5	6	7	8	9	10	Feet
Prototype	0	20	40	60	80	100	Feet					

NOTE:
Elevations refer to the prototype.
Dimensions refer to the model.

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING
HYDRAULIC DATA BRANCH

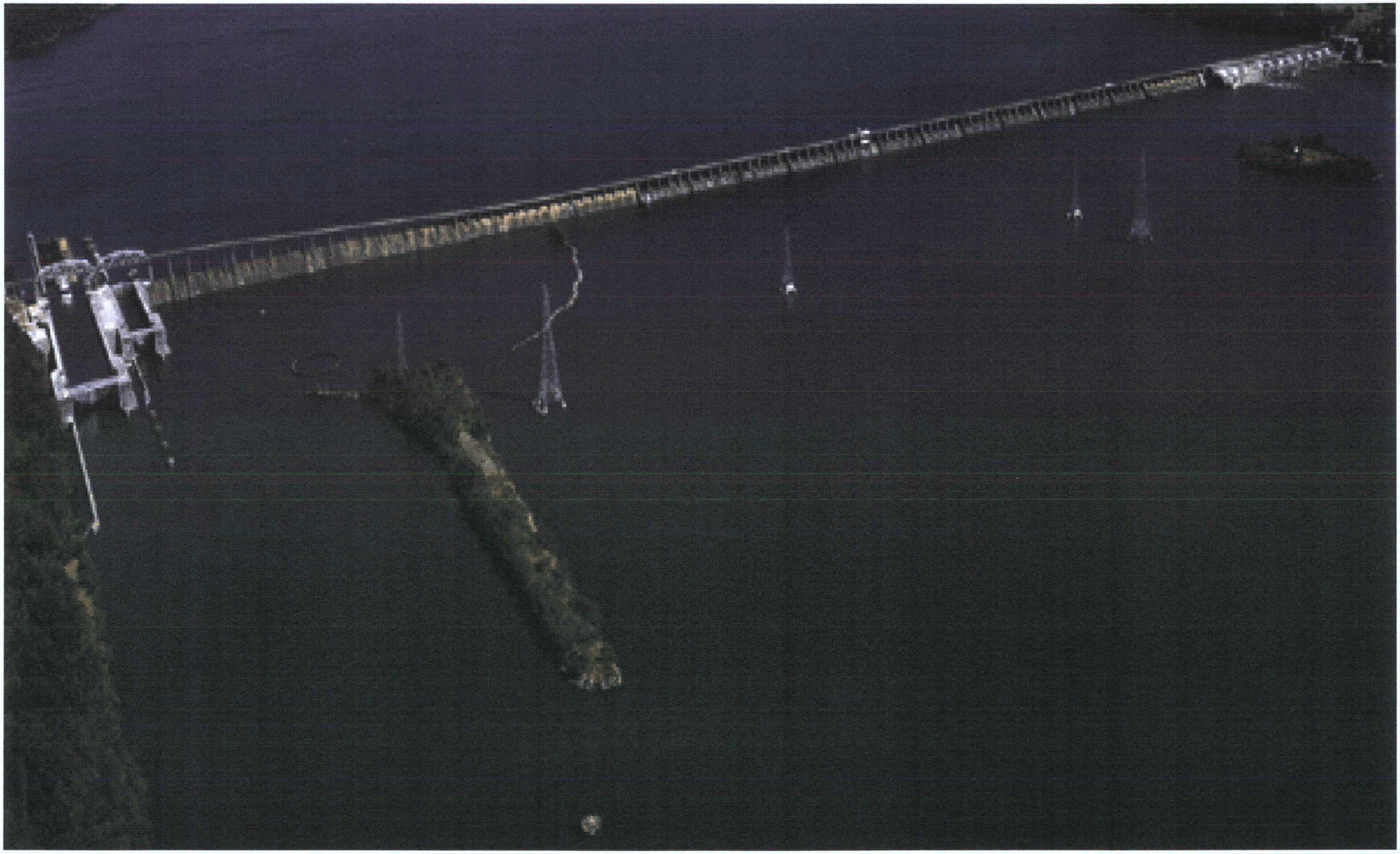
FORT PATRICK HENRY PROJECT
HYDRAULIC MODEL STUDIES

1:15 SCALE MODEL LAYOUT

CDQ000020080021

Attachment 5

WHEELER DAM



October 1999

RESERVOIR OPERATION OVERVIEW

Wheeler is a multipurpose main river project, one of 9 such projects located on the Tennessee River which provides a navigable waterway from the mouth of the river at Paducah, Kentucky, to the source of the river at Knoxville, Tennessee, some 652 river miles. Construction started in 1933, the dam was closed in 1936, and the original lock went into operation at that time. The four original hydro units went into commercial operation between 1936 and 1941. Four additional units were placed into commercial operation between 1948 and 1950. The last three units were placed into commercial operation in 1962 and 1963. A larger, modern lock was placed into operation in 1963.

In addition to serving as a vital navigation link on the Tennessee River, Wheeler provides limited flood reduction benefits for downstream locations, and also contributes hydroelectric generation. Under normal conditions, the annual pool elevation only varies approximately 6 feet at Wheeler Dam, due to original design considerations. Elevations along upper reaches of the reservoir vary considerably more, due to backwater effects based on upstream releases into Wheeler Reservoir. Wheeler Reservoir is fed by releases from TVA's Guntersville Dam located immediately upstream on the Tennessee River, and by releases from TVA's Tims Ford dam located upstream on the Elk River, in addition to unregulated inflows from the 4,611 square mile local drainage area.

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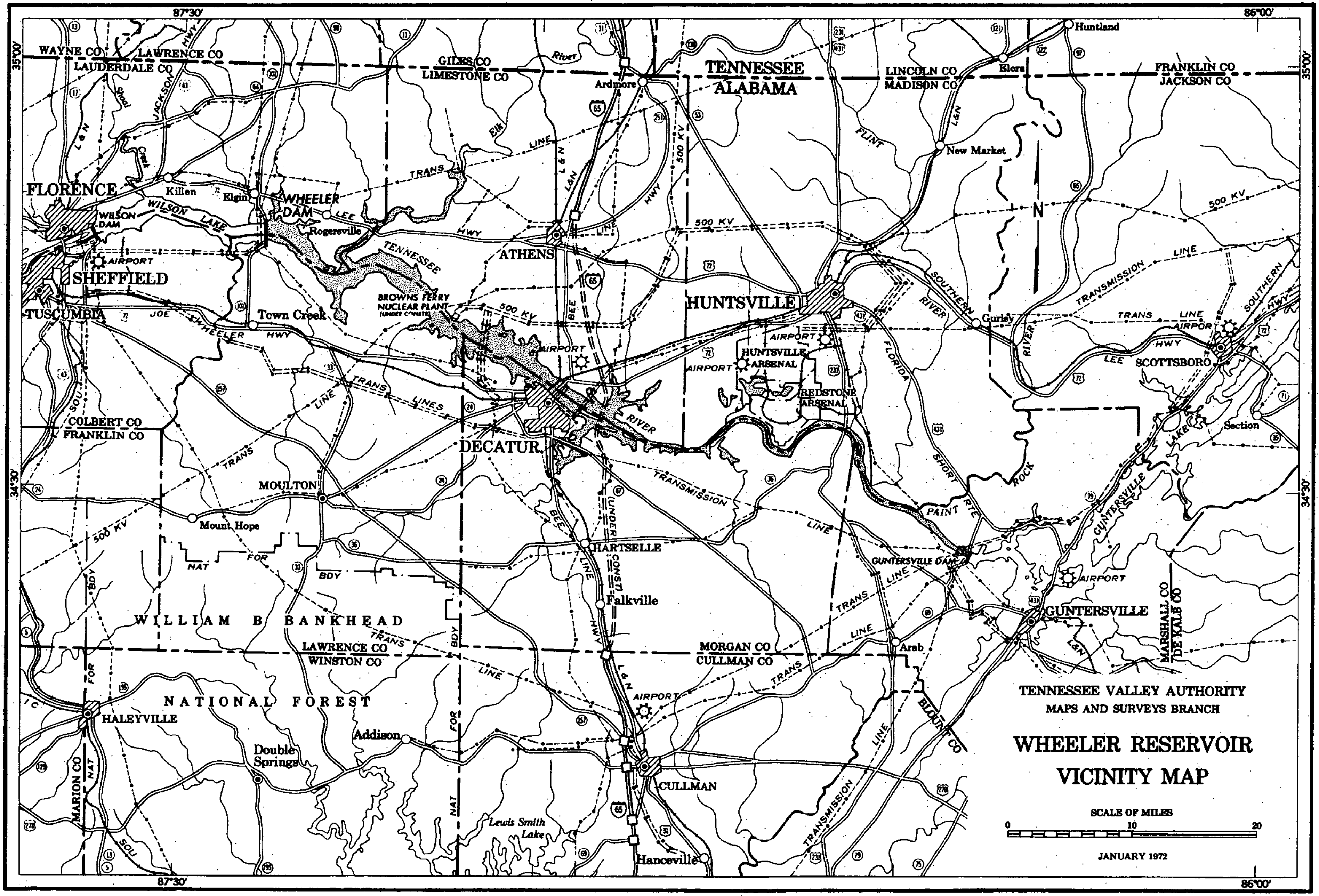

TENNESSEE VALLEY AUTHORITY
MAPS AND SURVEYS BRANCH
WHEELER RESERVOIR
VICINITY MAP
SCALE OF MILES
0 10 20
JANUARY 1972
TENNESSEE
ALABAMA
FLORENCE
SHEFFIELD
TUSCUMBIA
ATHENS
HUNTSVILLE
DECATUR
HARTSELLE
GUNTERSVILLE
SCOTTSBORO
CULLMAN
HALEYVILLE
MOULTON
WHEELER DAM
WILSON DAM
BROWNS FERRY NUCLEAR PLANT
GUNTERSVILLE DAM
HUNTSVILLE ARSENAL
REDSTONE ARSENAL
WILLIAM B BANKHEAD
NATIONAL FOREST
Killen
Elgin
Rogersville
Town Creek
Mount Hope
Falkville
Arab
Addison
Double Springs
Hanceville
Ardmore
Elora
Huntland
New Market
Gurley
Section
Lewis Smith Lake
WAYNE CO
LAWRENCE CO
LAUDERDALE CO
GILES CO
LIMESTONE CO
LINCOLN CO
MADISON CO
FRANKLIN CO
JACKSON CO
COLBERT CO
MORGAN CO
CULLMAN CO
WINSTON CO
MARION CO
MARSHALL CO
DE KALB CO
BLOUNT CO
87°30′
86°00′
35°00′
34°30′

FIGURE 1 - Dam Construction, 1935

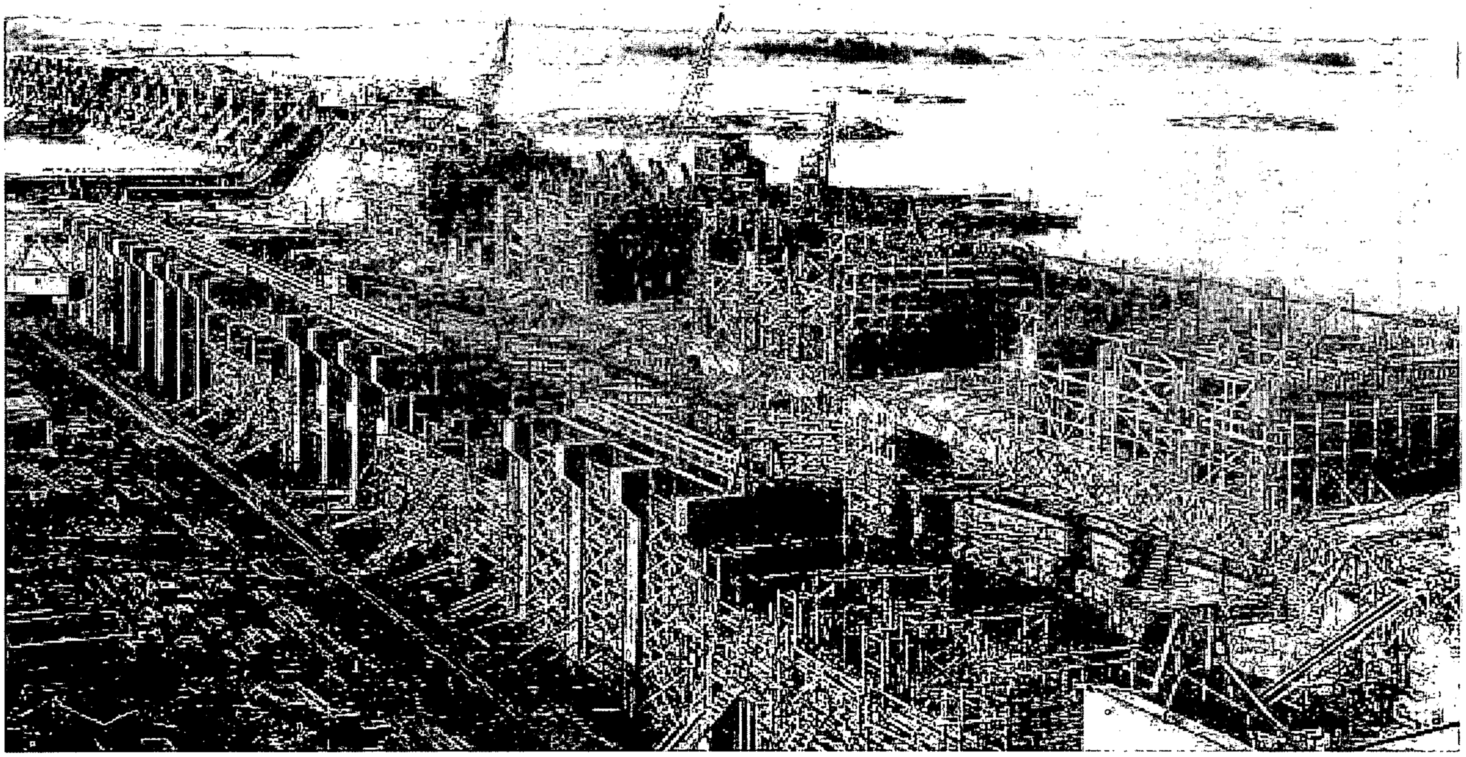


FIGURE 2 - Main and Auxiliary Locks, 1963

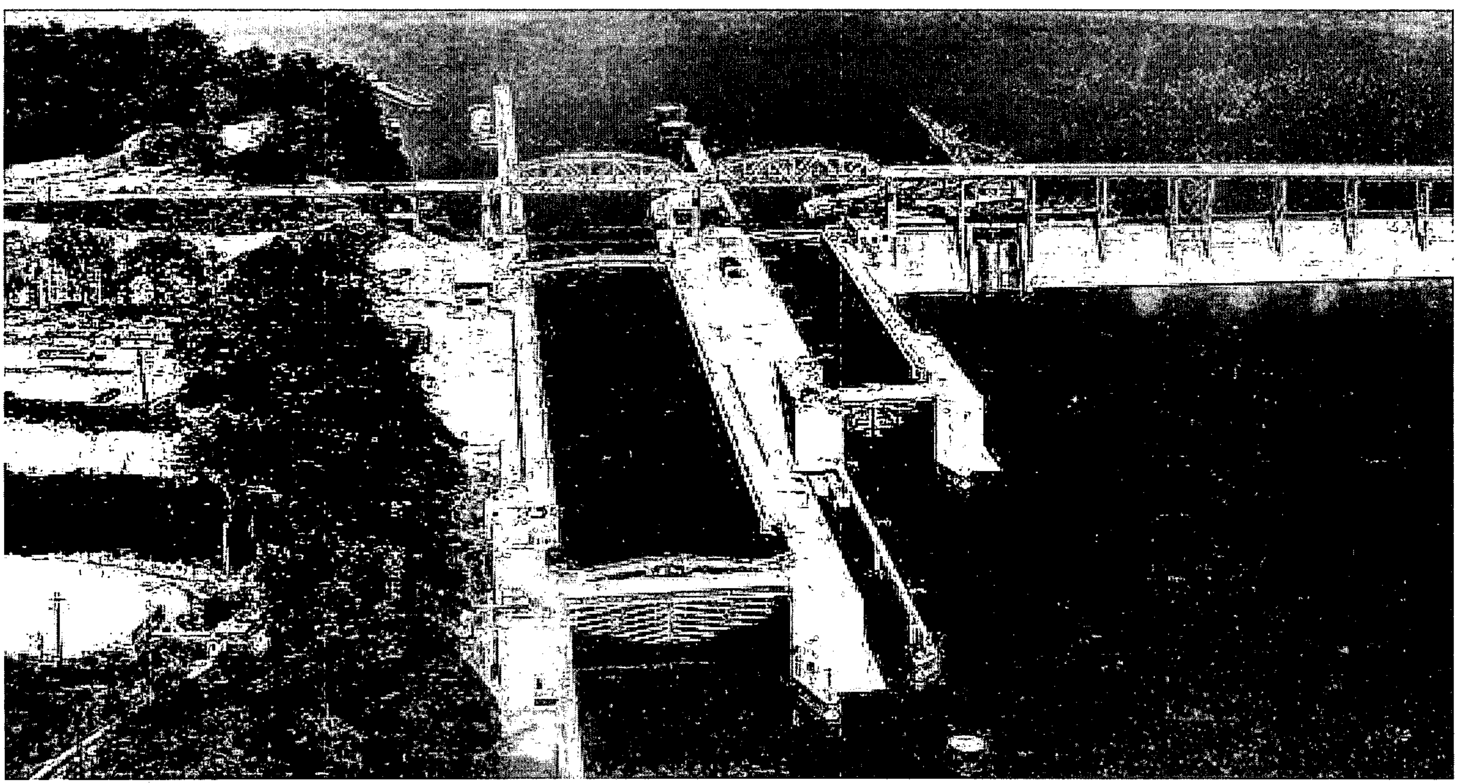
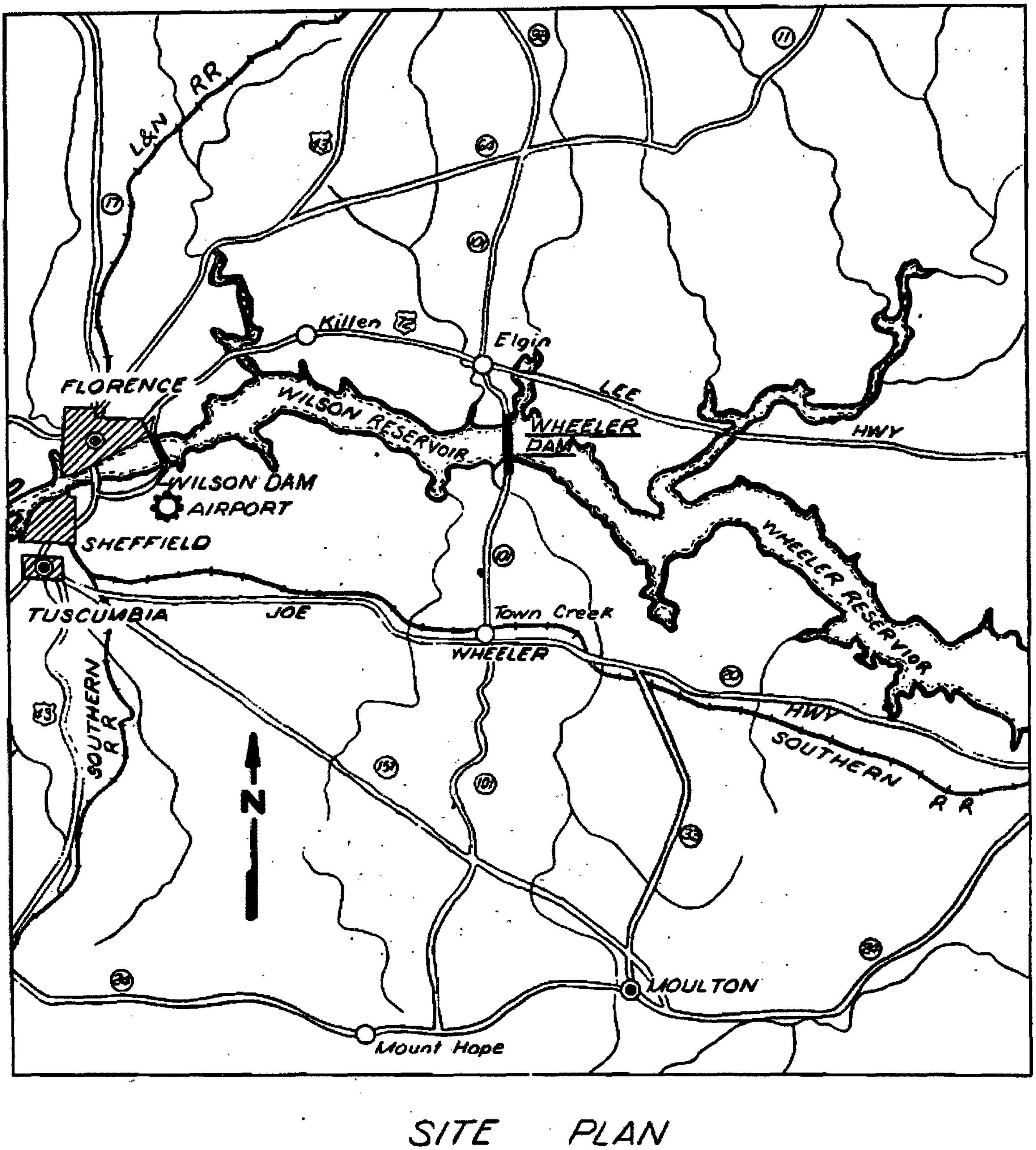


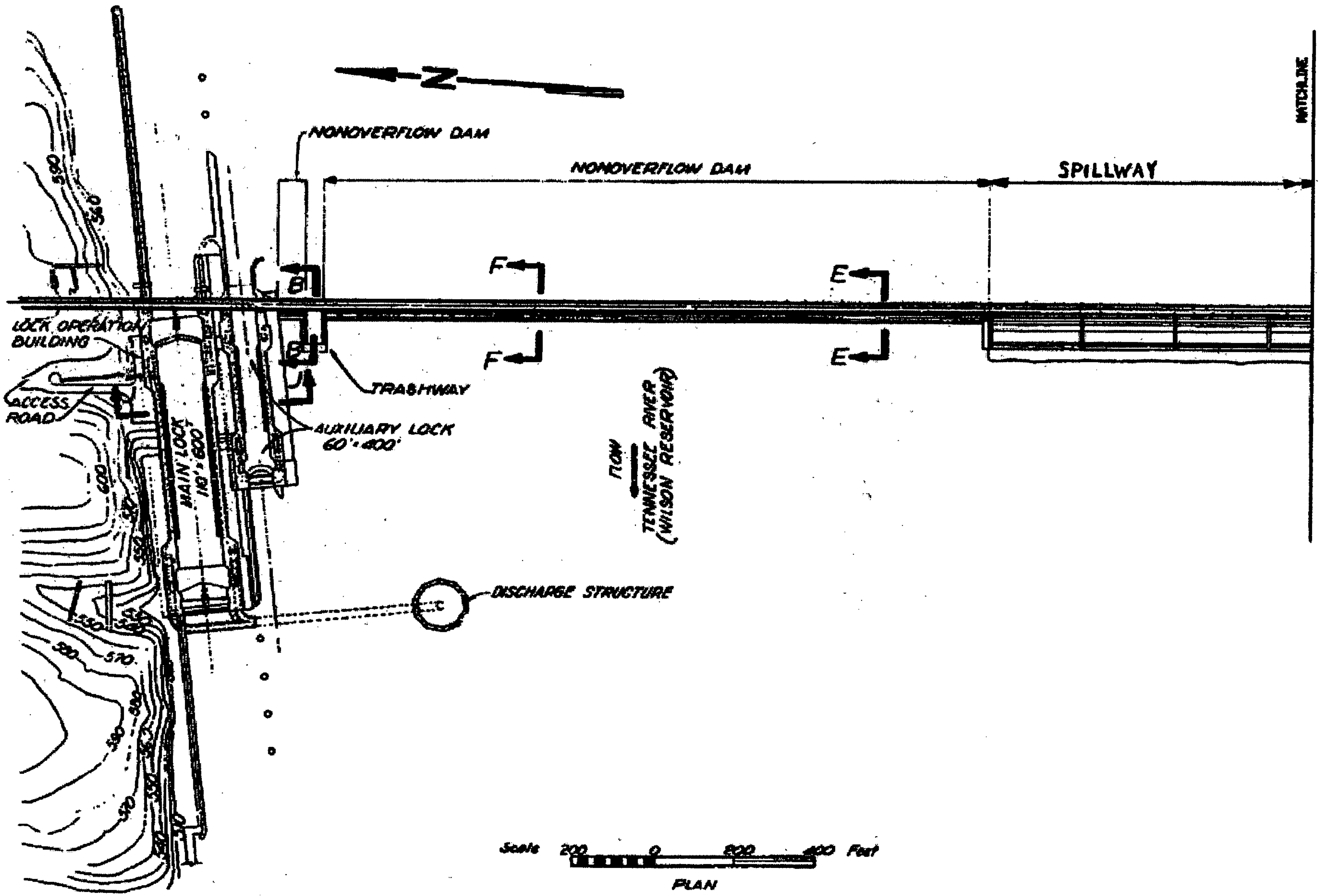
FIGURE 3



SITE PLAN

SCALE 0 5 10 15 20 MILES

FIGURE 4



NONOVERFLOW DAM
NONOVERFLOW DAM
SPILLWAY
MATCHLINE
F
F
E
E
B
B
LOCK OPERATION BUILDING
ACCESS ROAD
TRASHWAY
AUXILIARY LOCK 60'x400'
MAIN LOCK 110'x600'
FLOW
TENNESSEE RIVER (WILSON RESERVOIR)
DISCHARGE STRUCTURE
Scale 200 0 200 400 Feet
PLAN

FIGURE 4 (Cont.)

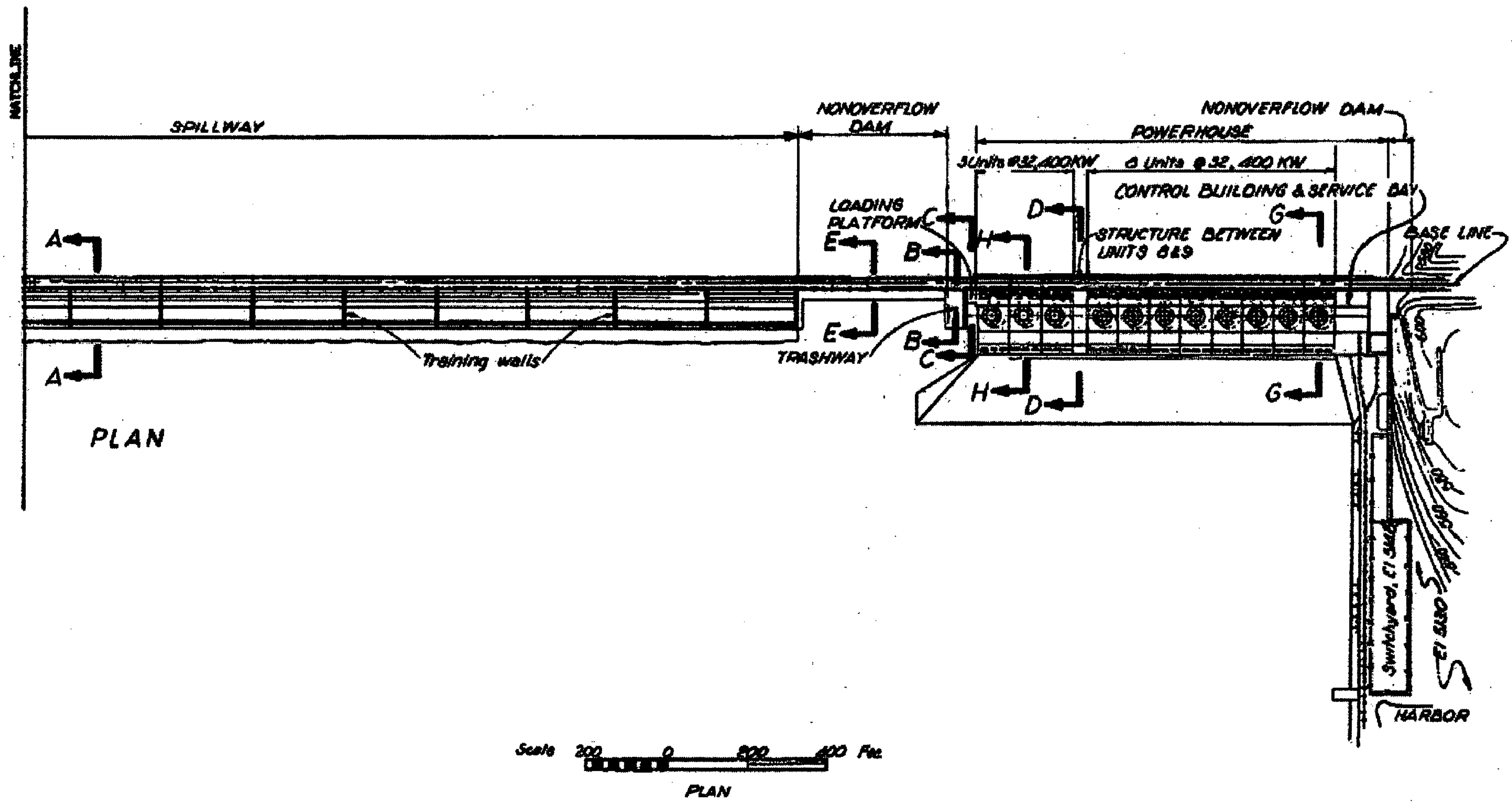
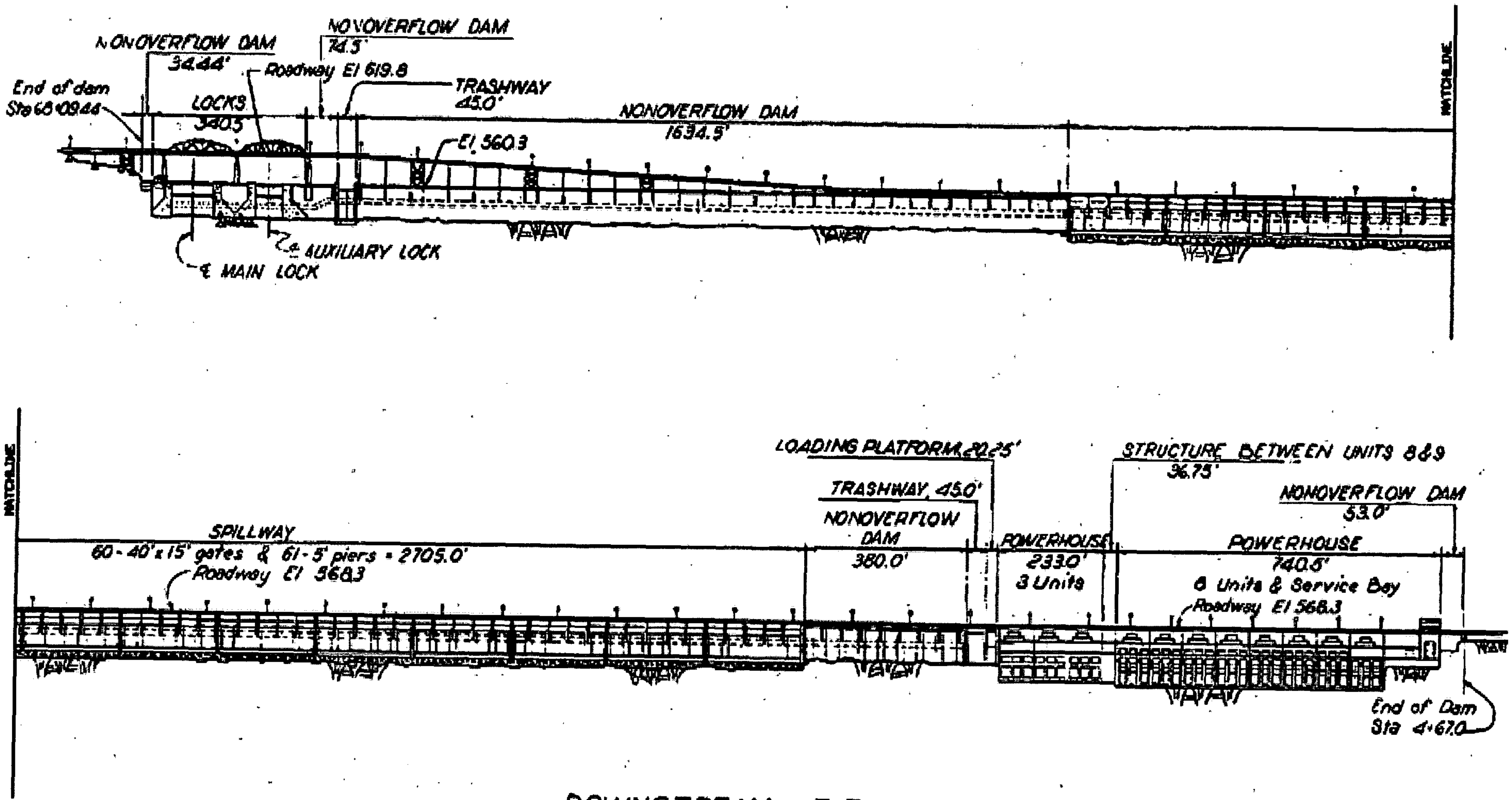


FIGURE 5



DOWNSTREAM ELEVATION

Scale 200 0 200 400 Feet

FIGURE 6

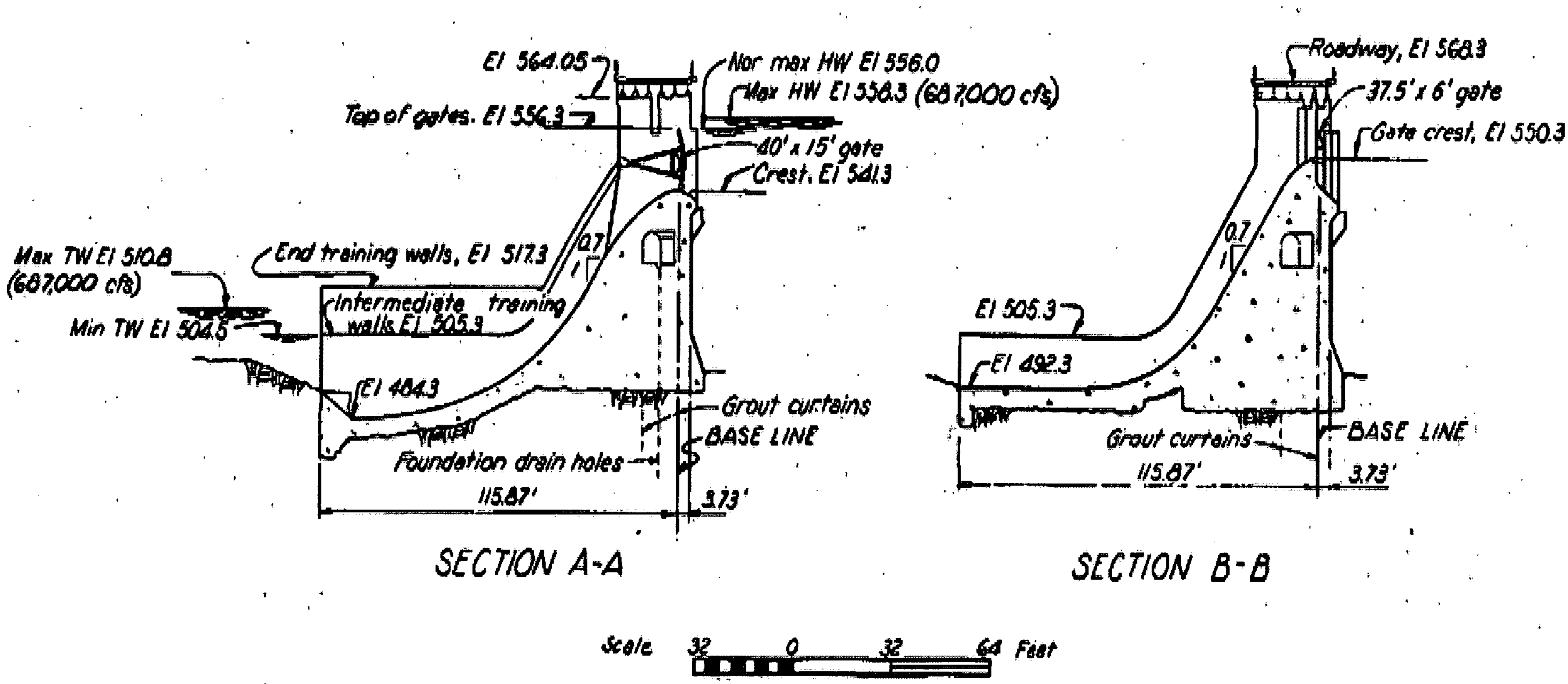

El 564.05
Nor max HW El 556.0
Max HW El 558.3 (687,000 cfs)
Top of gates. El 556.3
40' x 15' gate
Crest. El 541.3
Max TW El 510.8
(687,000 cfs)
End training walls, El 517.3
0.7
1
Intermediate training walls El 505.3
Min TW El 504.5
El 484.3
Grout curtains
BASE LINE
Foundation drain holes
115.87'
3.73'
SECTION A-A
Roadway, El 568.3
37.5' x 6' gate
Gate crest, El 550.3
0.7
1
El 505.3
El 492.3
BASE LINE
Grout curtains
115.87'
3.73'
SECTION B-B
Scale
32
0
32
64
Feet

FIGURE 7

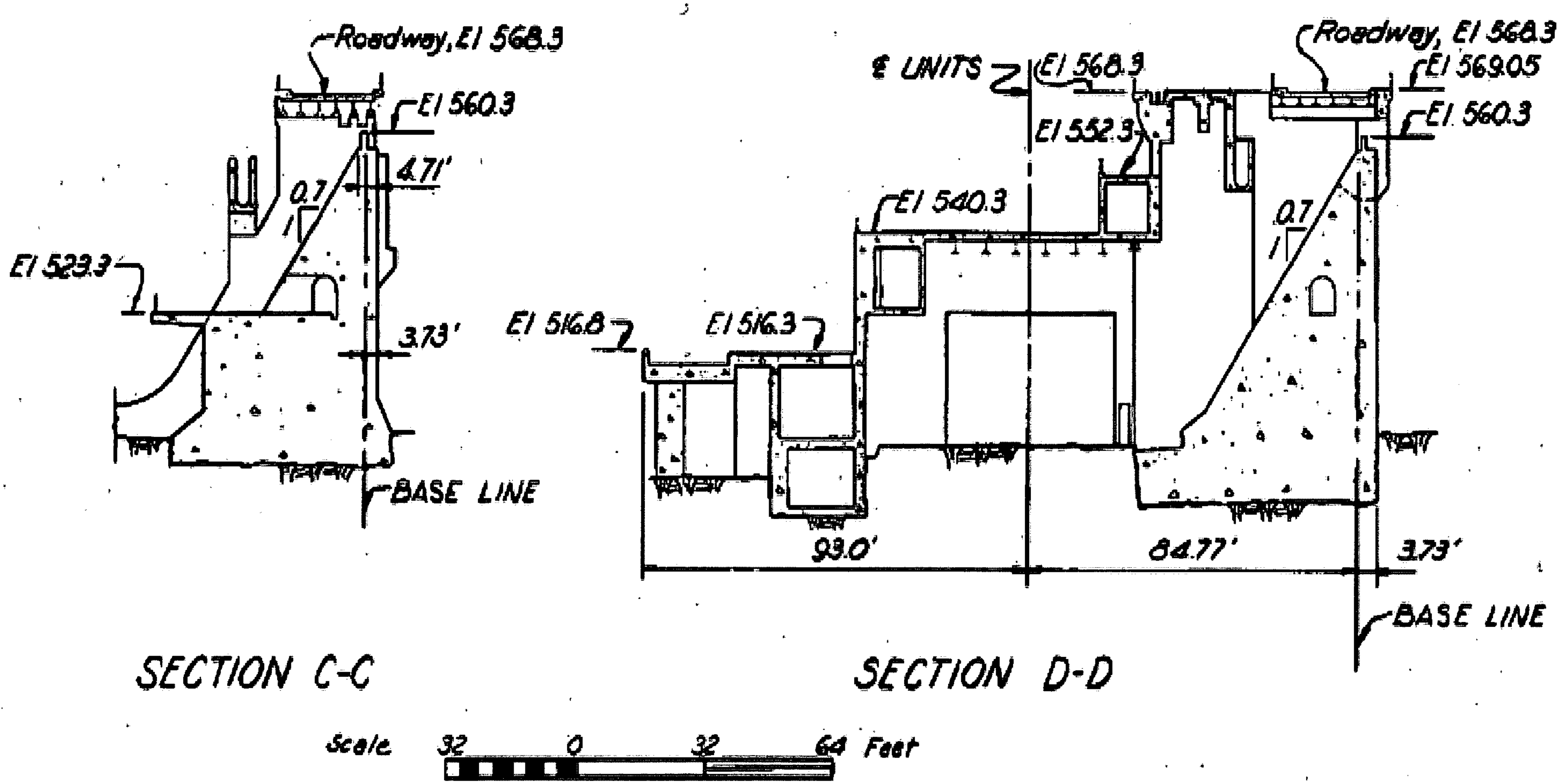

Roadway, El 568.3
El 560.3
4.71'
0.7
1
El 523.3
3.73'
BASE LINE
SECTION C-C
℄ UNITS
El 568.3
Roadway, El 568.3
El 569.05
El 560.3
El 552.3
El 540.3
0.7
1
El 516.8
El 516.3
93.0'
84.77'
3.73'
BASE LINE
SECTION D-D
Scale 32 0 32 64 Feet

FIGURE 8

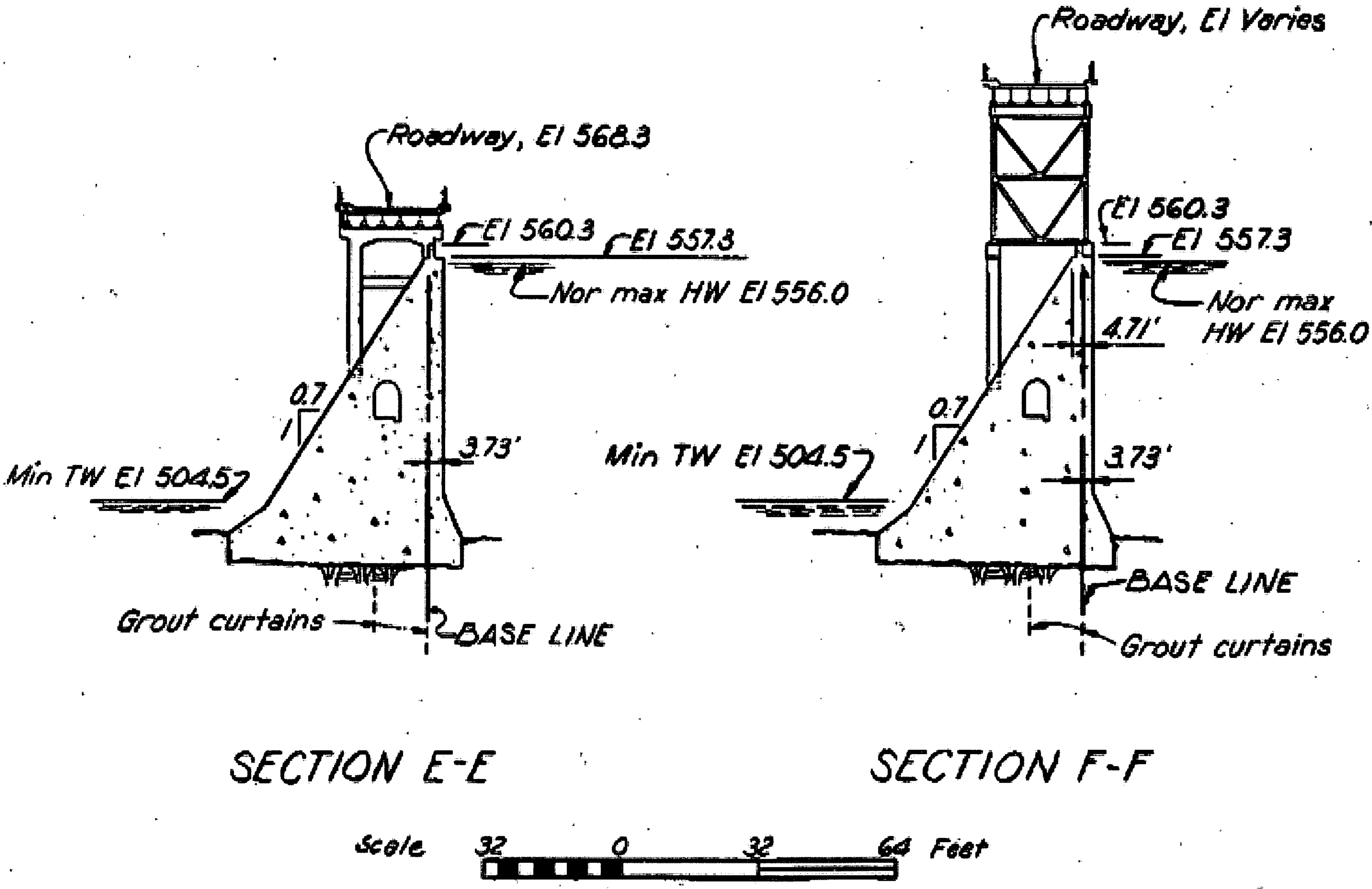
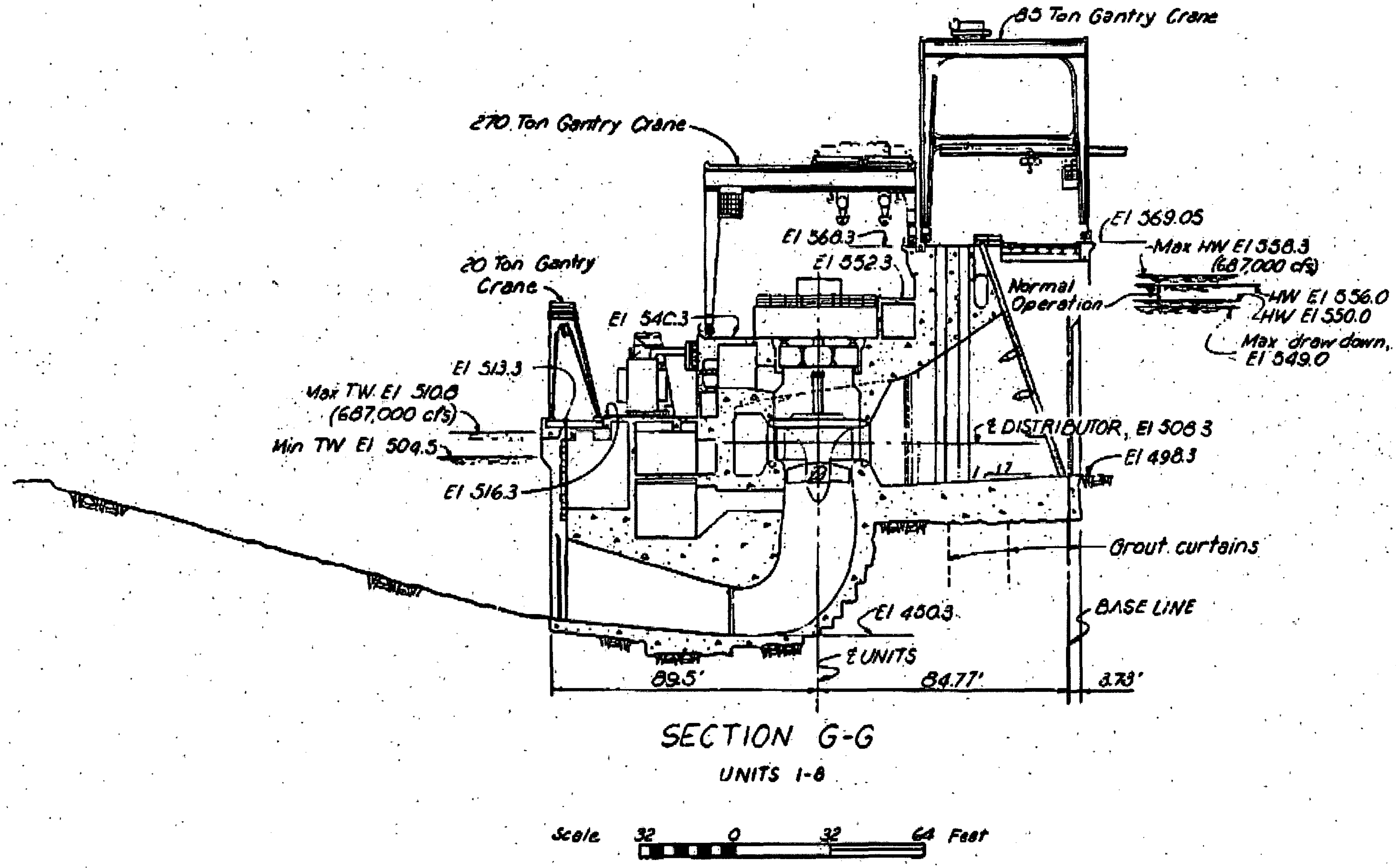

Roadway, El 568.3
El 560.3
El 557.8
Nor max HW El 556.0
0.7
1
3.73'
Min TW El 504.5
Grout curtains
BASE LINE
SECTION E-E
Roadway, El Varies
El 560.3
El 557.3
Nor max
HW El 556.0
4.71'
0.7
1
3.73'
Min TW El 504.5
BASE LINE
Grout curtains
SECTION F-F
Scale 32 0 32 64 Feet

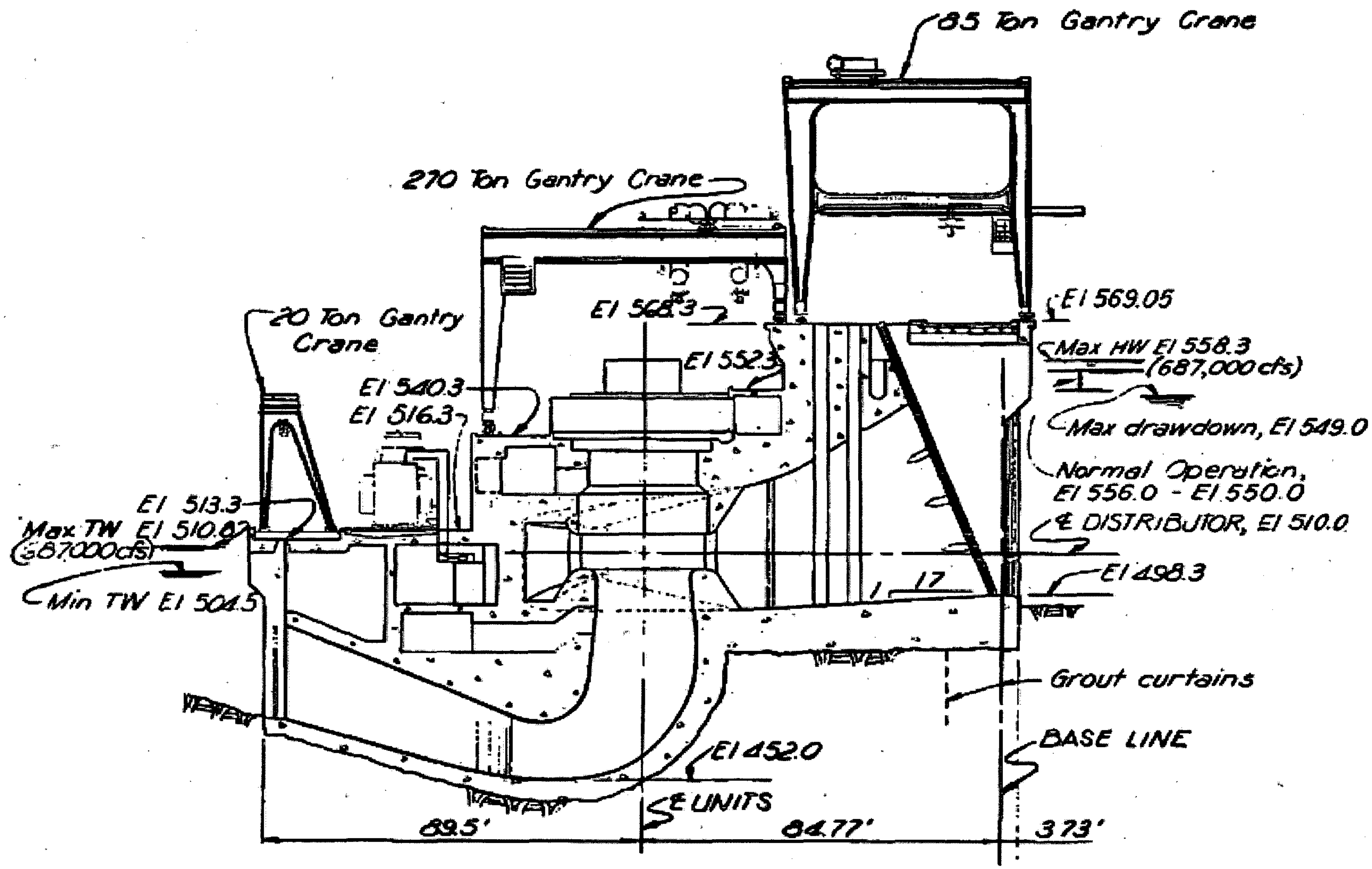
FIGURE 9



SECTION G-G

UNITS 1-8

FIGURE 10

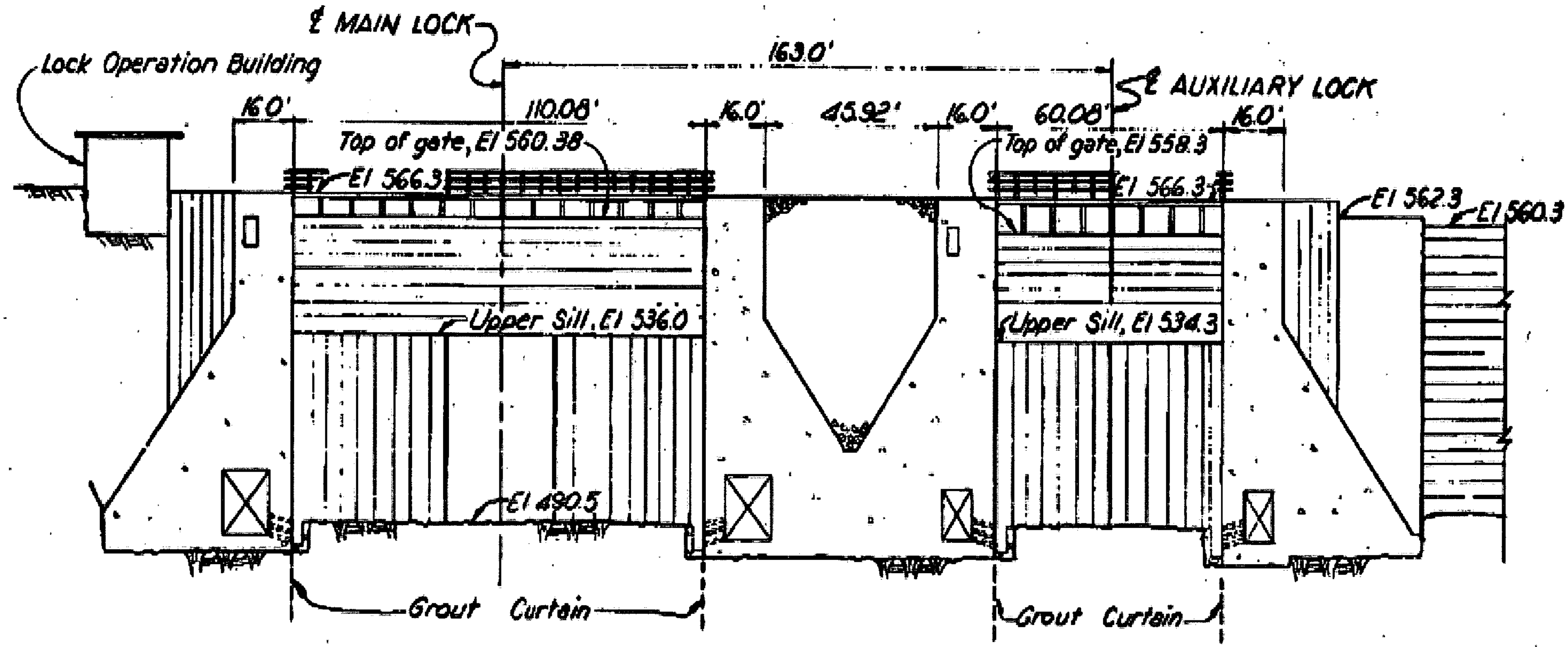


SECTION H-H

UNITS 9-11

Scale 32 0 32 64 Feet

FIGURE 11



SECTION J-J

Scale 32 0 32 64 Feet

FIGURE 12

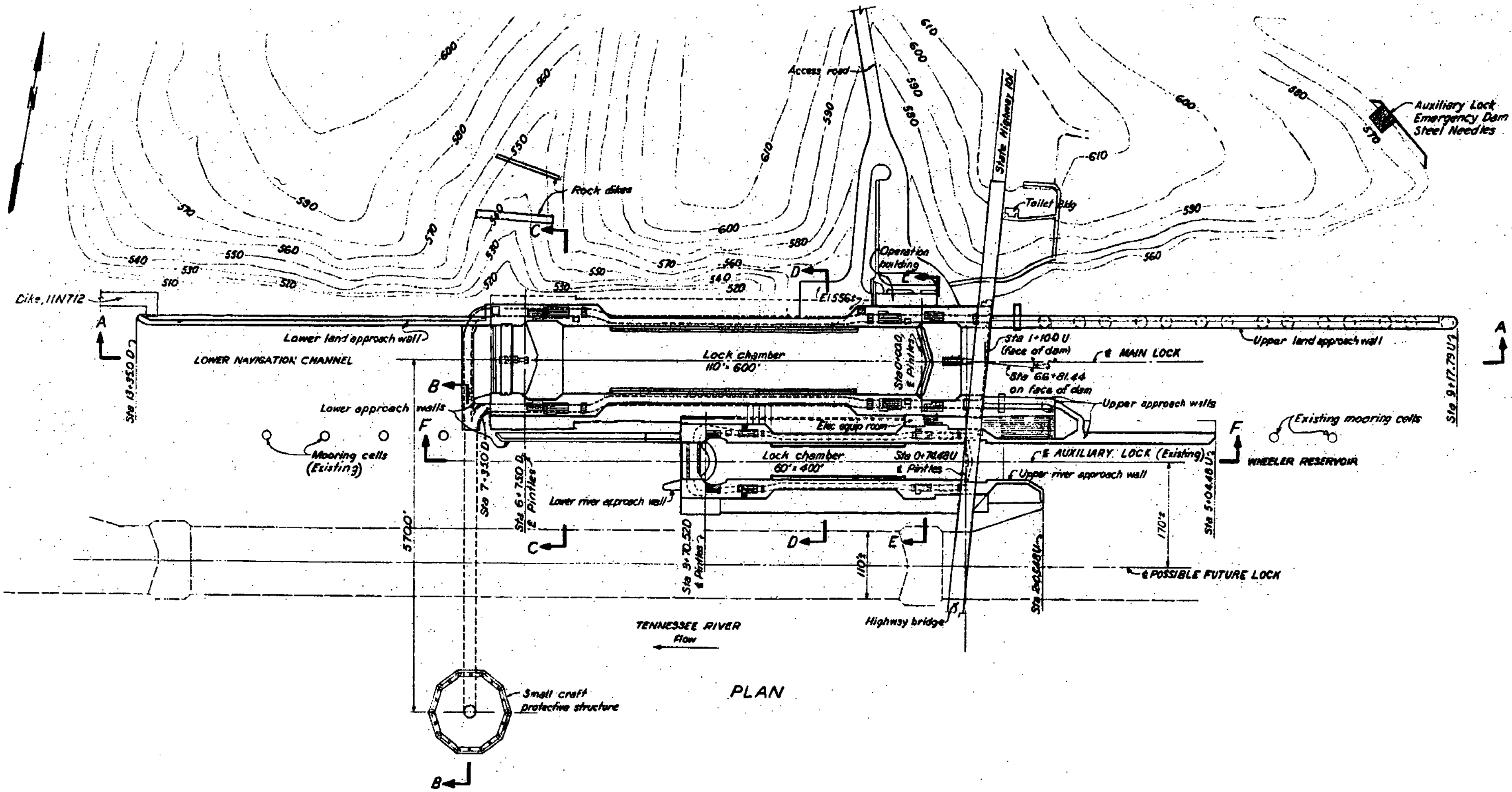
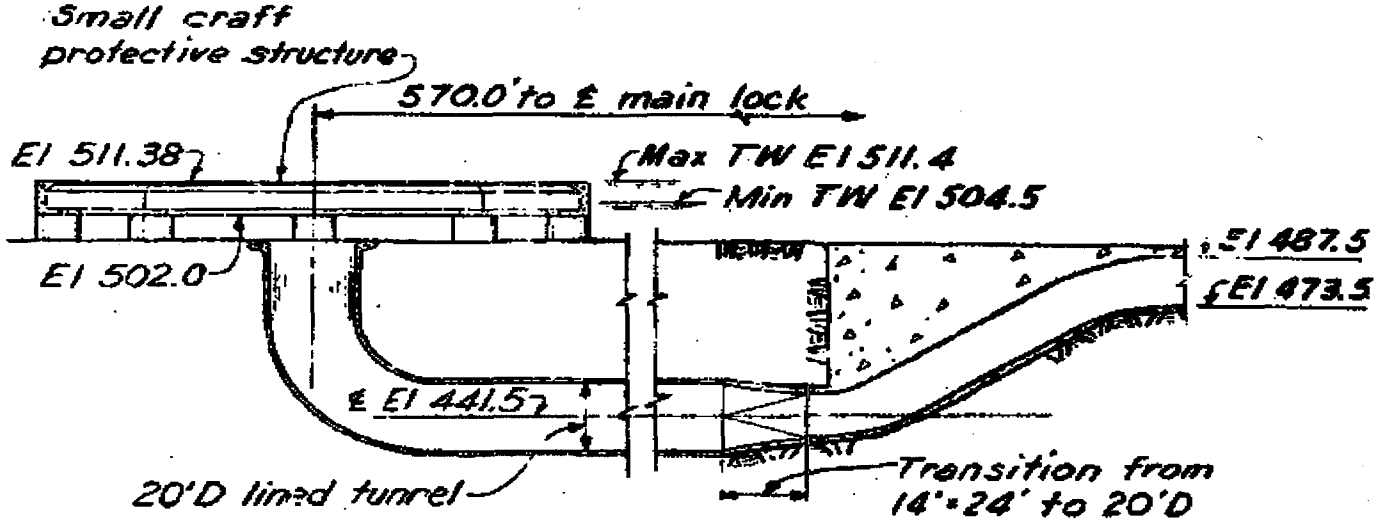
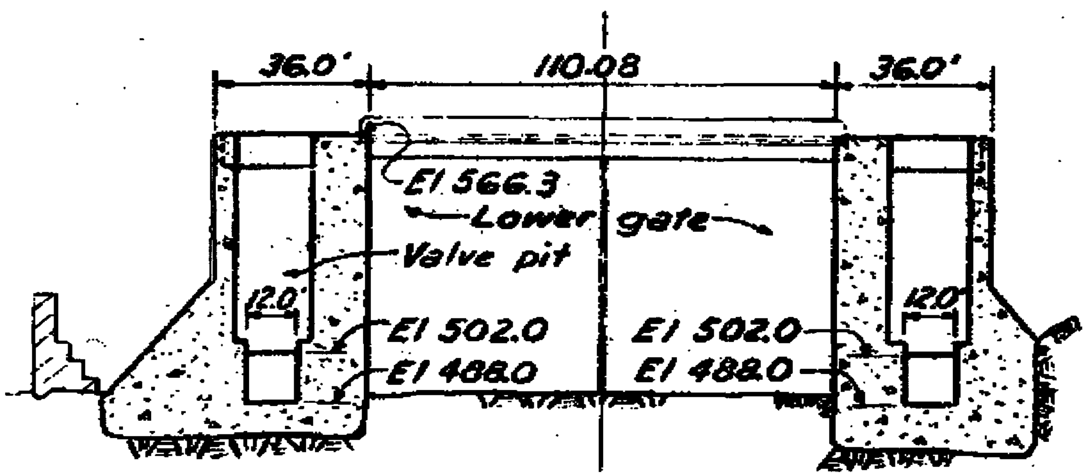

Access road
State Highway 101
Auxiliary Lock Emergency Dam Steel Needles
Rock dikes
Toilet Bldg
Operation building
Dike, 11N712
Lower land approach wall
LOWER NAVIGATION CHANNEL
Lock chamber 110' x 600'
Sta 1+10.0 U (face of dam)
℄ MAIN LOCK
Sta 66+81.44 on face of dam
Upper land approach wall
Upper approach walls
Lower approach walls
Existing mooring cells
Elec equip room
Mooring cells (Existing)
Lock chamber 60' x 400'
℄ AUXILIARY LOCK (Existing)
WHEELER RESERVOIR
℄ Pintles
Upper river approach wall
Lower river approach wall
℄ POSSIBLE FUTURE LOCK
TENNESSEE RIVER Flow
Highway bridge
Small craft protective structure
PLAN

FIGURE 13

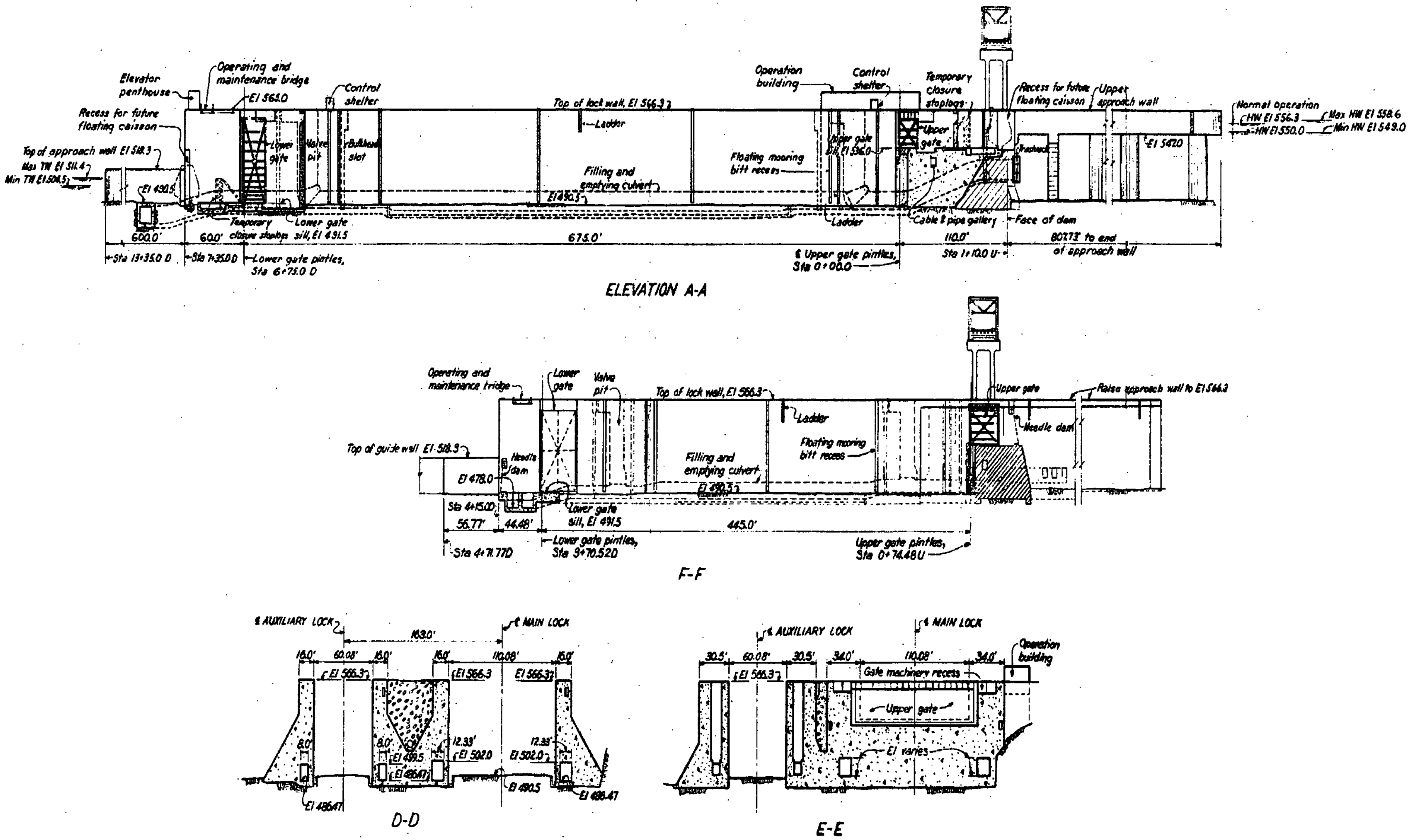


SECTION B-B



C - C

FIGURE 14


Elevator penthouse
Operating and maintenance bridge
El 565.0
Control shelter
Recess for future floating caisson
Top of approach wall El 518.3
Max TW El 511.4
Min TW El 504.5
El 490.5
Lower gate
Valve pit
Bulkhead slot
Top of lock wall, El 566.3
Ladder
Filling and emptying culvert
El 490.5
Temporary closure stoplogs
Lower gate sill, El 491.5
Operation building
Control shelter
Temporary closure stoplogs
Recess for future floating caisson
Upper approach wall
Floating mooring bitt recess
Upper gate sill, El 536.0
Upper gate
Ladder
Cable & pipe gallery
Face of dam
El 542.0
Normal operation
HW El 556.3
HW El 550.0
Max HW El 558.6
Min HW El 549.0
600.0'
60.0'
675.0'
110.0'
807.73' to end of approach wall
Sta 13+35.0 D
Sta 7+35.0 D
Lower gate pintles, Sta 6+75.0 D
℄ Upper gate pintles, Sta 0+00.0
Sta 1+10.0 U
ELEVATION A-A
Operating and maintenance bridge
Lower gate
Valve pit
Top of lock wall, El 566.3
Ladder
Upper gate
Raise approach wall to El 566.3
Needle dam
Top of guide wall El 518.3
Needle dam
El 478.0
Filling and emptying culvert
El 490.3
Floating mooring bitt recess
Sta 4+15.00
Lower gate sill, El 491.5
56.77'
44.48'
445.0'
Sta 4+71.77D
Lower gate pintles, Sta 3+70.52D
Upper gate pintles, Sta 0+74.48U
F-F
℄ AUXILIARY LOCK
℄ MAIN LOCK
163.0'
16.0'
60.08'
16.0'
16.0'
110.08'
16.0'
El 566.3
El 566.3
El 566.3
8.0'
8.0'
12.33'
12.33'
El 499.5
El 502.0
El 502.0
El 486.47
El 490.5
El 486.47
El 486.47
D-D
℄ AUXILIARY LOCK
℄ MAIN LOCK
30.5'
60.08'
30.5'
34.0'
110.08'
34.0'
Operation building
El 566.3
Gate machinery recess
Upper gate
El varies
E-E

WHEELER DAM

SUMMARY OF PRINCIPAL FEATURES

NOTE:
Elevations are based on the U.S.C. & G.S. 1929 General Adjustment.

LOCATION

On Tennessee River at river mile 274.9; in Lauderdale and Lawrence Counties, Alabama; 74.1 miles downstream from Guntersville Dam; 15.5 miles upstream from Wilson Dam; 29.5 miles below Decatur, Alabama; 95 miles north of Birmingham, Alabama; 18.5 miles from Southern Railway at Sheffield, Alabama; 8.5 miles from Southern Railway at Town Creek, Alabama.

CHRONOLOGY

Initial appropriation by Congress (except lock) .... June 16, 1933
Authorized by TVA Board of Directors .... September 21, 1933
Work started:
- On lock .... January 1933
- On dam .... November 21, 1933

Reservoir filling began .... October 3, 1936
Unit 1 in commercial operation .... November 9, 1936
Lock opened to traffic .... December 1, 1936
Unit 2 in commercial operation .... April 14, 1937
Units 3 and 4 authorized .... July 31, 1939
Unit 3 in commercial operation .... January 12, 1941
Unit 4 in commercial operation .... March 13, 1941
Units 5 and 6 authorized .... January 15, 1942
Units 7 and 8 authorized .... August 12, 1947
Unit 5 in commercial operation .... October 30, 1948
Unit 6 in commercial operation .... February 23, 1949
Unit 7 in commercial operation .... December 31, 1949
Unit 8 in commercial operation .... March 4, 1950
Units 9-11 authorized .... September 24, 1959
Main lock construction authorized .... December 17, 1959
Units 9-11 construction started .... February 25, 1960
Main lock construction started .... October 3, 1960
Existing lock failed .... June 2, 1961
Existing lock reconstruction authorized .... August 10, 1961
Reconstructed auxiliary lock resumed operation .... April 18, 1962
Unit 9 in commercial operation .... December 21, 1962
Main lock opened to traffic .... May 13, 1963
Unit 10 in commercial operation .... June 5, 1963
Unit 11 in commercial operation .... December 18, 1963
Safety Modifications for Probable Maximum Flood (PMF) . September 1982
Generator & Turbine Modernization (Units 9-11) .... July 2000

PROJECT COST

Initial project, including 2 units	$30,378,889
Original navigation lock (by War Department)	1,734,038
Addition of units 3 and 4	3,675,281
Addition of units 5, 6, 7, and 8	10,591,709
Addition of units 9, 10, and 11	19,876,884
Addition of main lock	15,632,407
Reconstruction of original lock	6,801,674
Generator and Turbine Modernization (Units 9-11)	$21,700,000
Safety Modification for Probable Maximum Flood	330,000
Total, including switchyard	$110,720,882

STREAMFLOW

Drainage area at dam:	
Total	29,590 sq. miles
Uncontrolled (below Guntersville and Tims Ford Dams)	4,611 sq. miles
Gaging station discharge records:	
Florence, Alabama, October 1894 to date; drainage area	30,810 sq. miles
Maximum known flood at dam site:	
Natural (1897)	443,000 cfs
Since closure (March 1973)	411,900 cfs
Average unregulated flow at dam site, estimated (1903-1999)	49,800 cfs
Minimum daily natural flow at dam site (1925), approx	3,900 cfs

RESERVOIR

Counties affected:	
State of Alabama	Lauderdale, Lawrence, Limestone, Madison, Marshall, Morgan
Reservoir land at May 31, 1996:	
Fee simple	76,226 ac.
Total	76,226 ac.
Operating levels at dam:	
Probable maximum flood elevation	el. 567.7
500 year flood elevation	el. 557.3
100 year flood elevation	el. 557.3
Maximum probable flood elevation	el. 558.2
Maximum used for design (687,000 cfs)	el. 558.3
Top of gates (area 68,000 ac.)	el. 556.3
Summer pool (area 67,070 ac.)	el. 556.0
Winter pool (area 45,450 ac.)	el. 550.0

RESERVOIR (CONT.)

Backwater, length to Guntersville Dam .... 74.1 miles
Shoreline, length at normal maximum pool level:
    Main shore .... 899 miles
    Islands .... 164 miles
    Total .... 1,063 miles
Original river area (to Guntersville Dam) .... 17,600 ac.
Storage (flat pool assumption):
    Total volume:
        At top of gates (el. 556.28) .... 1,071,000 ac.-ft*
        At normal maximum pool (el.556.0) .... 1,050,000 ac.-ft*
        At normal minimum pool (el. 550.0) .... 720,000 ac.-ft*
Controlled flood storage, January 1 to
  March 15 (el. 556.28-550.0) .... 351,000 ac.-ft

*Includes dewatering projects.

TAILWATER

Maximum used for design (687,000 cfs) .... el. 510.8
Maximum known flood (March 1973) .... el. 510.65
Full plant operation (11 units) .... el. 506-508
Minimum level .... el. 504.5

HEAD (Gross)

Maximum static (el. 556.28-504.5) .... 51.78 ft
Normal operating range .... 41 to 50 ft
Average operating .... 46 ft

RESERVOIR ADJUSTMENTS

Clearing below el. 556 .... 31,460 ac.
Drainage of isolated pools .... 48,072 cu. yd
Preparation of sailing line .... 872 ac.
Highways:
    State .... 4.5 miles
    County .... 21.4 miles
    Tertiary .... 4.5 miles
    Total .... 30.4 miles
Railroads .... 5.4 miles
Bridge adjustments (highway 5,212 ft; railroad 383 ft) .... 35 bridges
Concrete box culverts 14
Families relocated 842
Graves .... 242 agreements; 176 removals
Utilities adjusted or constructed .... 25 miles

NAVIGATION FACILITIES

NAVIGATION CHANNEL

Length of channel for 9-ft navigable depth
(to Guntersville Dam) .... 71.7 sailing miles
Minimum flat pool level to maintain
9-ft navigable depth .... el. 550.3
Length of dredged navigable channel:
Below lock .... 2.0 miles
Upper end of pool .... 5.6 miles

NAVIGATION LOCKS

MAIN LOCK (See Figure 15)

Location .... Right (north) bank
Lock chamber, clear .... 110 by 600 ft
Lift (maximum), el. 504.5 to el. 556.3 .... Approx. 52 ft
Gate sills .... Upper, el. 536.0; lower, el. 491.5
Minimum depth over sills .... 13.0 ft
Top of upstream approach walls .... el. 566.3
Top of chamber walls .... el. 566.3
Top of lower approach walls .... el. 518.3
Filling and emptying system ...... Multiple-port type; 416 8-in. dia. ports in each wall
Estimated average lockage time
(checking to regaining speed) .... 40 min
Vertical clearance under bridge (min.) .... 59 ft
Foundation .... Limestone
Lock gate top .... Upper, el. 560.58; lower, el. 560.58
Lock gate height .... Upper, 24.68 ft; lower, 69.59 ft
Provision for future .... Space available on river side of auxiliary lock

NAVIGATION FACILITIES (CONT.)

NAVIGATION LOCKS (CONT.)

AUXILIARY LOCK (See Figure 15)

(Portion downstream of dam reconstructed 1961-1962)
Location .... Right (north) side adjacent to river side main lock
Lock chamber, clear .... 60 by 400 ft
Lift (maximum), el. 504.5 to el. 556.3 .... Approx. 52 ft
Gate sills .... Upper, el. 534.3; lower, el. 491.5
Minimum depth over sills .... Upper, 14.7 ft; lower, 13.0 ft
Top of upstream approach walls .... el. 566.3
Top of chamber walls .... el. 566.3
Top of downstream approach walls .... el. 518.3
Filling and emptying system .... Multiple-port type; 216 8in. dia. ports in each wall
Estimated lockage time (checking to regaining speed) .... 40 min
Lock gate top .... Upper, el. 558.0; lower, el. 558.10
Lock gate height .... Upper, 25.0 ft; lower, 67.49 ft

FIGURE 15 - Main and Auxiliary Locks, October 1999

DAM

(See Figure 16)

Material and type .... Concrete gravity nonoverflow dam and spillway; concrete powerhouse intake; navigation locks

Lengths:

- Nonoverflow dam .... 2,176 ft
- Spillway .... 2,705 ft
- Trashways (2) .... 90 ft
- Powerhouse intake .... 1,031 ft
- Navigation locks .... 340 ft
- Total .... 6,342 ft

Maximum height, foundation to top of piers .... 72 ft

Maximum width at base:

- Spillway section only .... 58 ft
- Including apron .... 124 ft

Deck level .... el. 568.3 over spillway,rising to el. 619.8 over locks

Top of nonoverflow dam .... el. 560.3

Outlet facilities:

- Spillway clear opening (60 openings at 40 ft) .... 2,400 ft (See Figure 16)
- Spillway crest level .... el. 541.3
- Trashway crest level .... el. 550.3
- Crest gates .... 60 radial gates, 40 ft wide, 15 ft high, separated by 5-ft-thick piers

Trash gates .... 2 fixed-wheel lift gates, 37.5 ft wide, 6 ft high

Gate hoists .... Fixed hoists for each gate

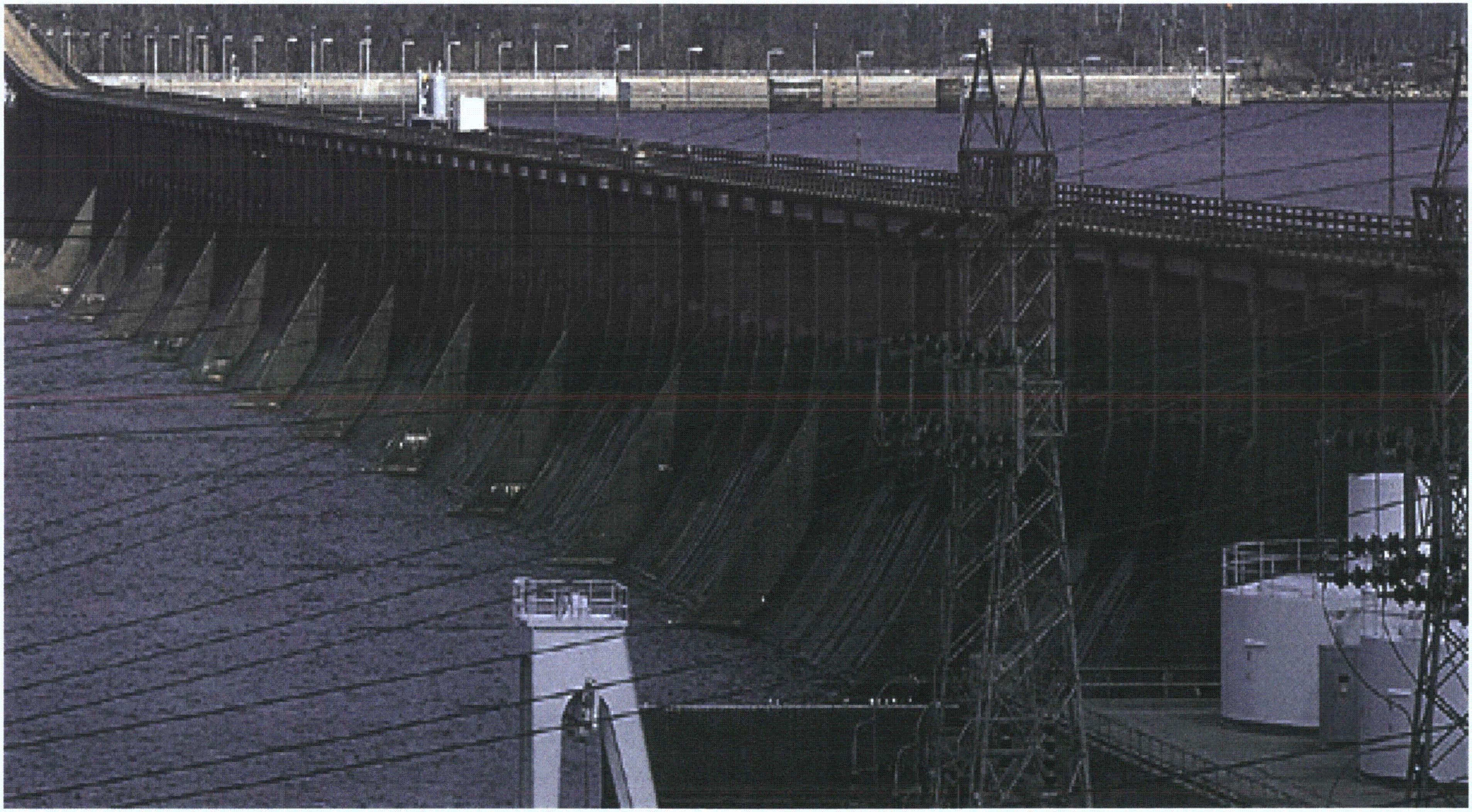
Spillway capacity:

- HW el. 558.3 (design level) .... 665,000 cfs
- HW el. 556.3 (top of gates) .... 542,000 cfs

Highway .... 20 ft wide, on bridge over dam

Foundation .... Fort Payne limestone

FIGURE 16 - Spillway Gates, February 2000



POWER FACILITIES

INTAKES

Number .... 11 (each with 3 bays)
Dimensions of one rack opening .... 18 ft wide by 50 ft high
Gross area at racks .... 2,700 sq. ft per unit
Gates .... Fixed-wheel lift type, 18 ft clear opening by 38 ft 4 in. high: 7 active, 9 inactive (without Wheels); 18 ft clear 42 ft in. high
Crane .... One 85-ton gantry with 5-ton monorail hoist

POWERHOUSE (See Figure 17)

Generating capacity, 11-unit total .... 457,500 kW
Type of construction .... Outdoor; reinforced concrete and structural steel
Principal outside dimensions
including service bay .... 973.5 ft long by 181.5 ft wide by 125 ft high
Service bay .... 130 by 181.5 ft
Draft tubes:
Type .... Elbow, 3 openings
Horizontal length (centerline of
turbine to downstream face) .... 85.0 ft
Vertical distance from distributor
centerline to draft tube floor .... 58.0 ft
Net area at outlet opening .... 1,320 sq. ft
Gates .... 3 sliding type, 18 ft clear opening by 25.34 ft high, 20 tons each
Crane .... One 20-ton gantry
Erecting crane .... One 270-ton gantry, two 135-ton main hooks and two 20-ton auxiliary hooks

FIGURE 17 - Powerhouse, February 2000

POWER FACILITIES (CONT.)

HYDRAULIC TURBINES

	Units 1-8	Units 9-11
Number	8	3
Manufacturer	Baldwin-Southwark Corp.	Voith Hydro Inc.
Type	fixed propeller	diagonal flow
Rated capacity (each)	45,000 hp at 48-ft net head	59,890 hp at 45-ft net head
Rated speed	85.7 rpm	78.3 rpm
Maximum runaway speed	160 rpm	126.9 rpm
Specific speed at rating	144	164.4
Value of sigma at rating	0.78	0.85
Diameter of runner	264 in.	264 in.
Diameter of guide vane circle	312 in.	312 in.
Diameter of lower pit	364 in.	364 in.
Spacing of turbines, center to center of units	76 ft	76 ft
Draft tubes (see Powerhouse)	elbow type	elbow type
Governors	Woodward, cabinet actuator type	
Heaviest assembly to be lifted by crane	432,000 lb	400,000 lb
Tailwater safety factor (at rated conditions)	--	3.2 ft

POWER FACILITIES (CONT.)

GENERATORS (See Figure 18)

UNITS 1-8:

Number 8
Manufacturer .... General Electric Co.
Type .... Enclosed, water-cooled, vertical-shaft; removable weatherproof cover furnished by TVA
Stator windings all replaced between 1981 and 1987:
 Rating .... 39,000 kVA, 35,100 kW, 1632 A, 60 degrees C rise, 0.9 pf, 13.8 kV, 3 ph, 60 Hz
 Capacity .... 44,850 kVA, 40,365 kW, 1876 A, 80 degrees C rise
Efficiency (tested):
 At rated kVA, 1.0 pf .... 97.90 percent
 At 75% kVA, 0.9 pf .... Units 1-2, 97.32 percent; units 3-8, 97.00 percent
Flywheel effect, unit 1:
 Generator (calculated) 61,260,0001b-ft2
 Turbine (calculated) 5,154,0001b-ft2
 Generator and turbine (tested) 66,797,000 lb-ft2
Thrust bearing:
 Units 1-2 .... GE, dia. 93 in., max. load 1,000 tons
 Units 3-8 ...... Kingsbury, dia. 93 in. max. load 1,000 tons
Neutral reactor:
 Units 1-2 .... 0.858 ohm, 8000 A, 1 min
 Units 3-8 .... 0.875 ohm, 8000 A, 1 min
Exciters:
 Main .... 200 kW, 250 V
 Pilot .... 17 kW, 250 V
Weight of heaviest crane lift, rotor:
 Units 1-8 .... 212.5 tons
 Diameter over air housing, less trim .... 516 in.
Diameter of stator bore .... 352 in.
Top of pilot exciter:
 Above stator soleplates .... 199.37 in.
 Above generator floor .... 227 in.

UNITS 9-11:

Number 3
Manufacturer .... American Elin Corp.
Type .... Enclosed, water-cooled, vertical-shaft
Unit 9 stator winding replaced in 1983
Units 10 and 11 stator windings replaced in 1993
Rating .... 48,500 kVA, 43,650 kW, 2029 A, 80 degrees C rise, 0.9 pf, 13.8 kV, 3 ph, 60 Hz
Capacity .... 41,400 kVA, 37,260 kW, 1732 A, 80 degrees C rise

POWER FACILITIES (CONT.)

GENERATORS (CONT.)

UNITS 9-11 (CONT.):

Efficiency (calculated):
- 115 percent rated kVA and 0.9 pf .... 97.16 percent
- 100 percent rated kVA and 0.9 pf .... 97.09 percent
- 75 percent rated kVA and 0.9 pf .... 96.7 percent

Flywheel effect (including turbine) 67,050,000 lb-ft2
Thrust bearing .... Kingsbury-type thrust and guide bearing; max. load 881.9 tons
Neutral reactor .... 8 ohm, 1000 A, 30 sec.
Exciters:
- Main .... 278 kW, 250 V
- Pilot .... 12.5 kW, 250 V

Weight of heaviest crane lift .... 242 tons
Diameter of stator bore .... 355 in.
Generator switchgear .... 13.8 kV, 2000 A continuous, 1500 MVA interrupting capacity
Generator main cables, generator to switchgear .... 15 kV, 2000 mcm
Generator main bus, switchgear to transformers .... Segregated phase, 15 kV,aluminum channel on porcelain insulators, TVA design and construction

GENERATOR AND TURBINE MODERNIZATION

Wheeler Units 9, 10, and 11 were modernized starting in July 1996 and are expected to be completed in September 2000. Principal components replaced were the turbine runner, generator air coolers and fans/baffles, generator leads and bus, protective relaying, pilot/main exciters with static excitation, brake shoes and seals, strainers and backflush system, shear pin alarm system, supply and return isolation valves, air cooler vent piping, and vent valves. Components rehabilitated were the turbine guide bearing, wicket gates, throat rings, shift ring system, and proportioning valves.

FIGURE 18 - Generating Units, February 2000

POWER FACILITIES (CONT.)

ELECTRIC CONTROLS

From control room in powerhouse:
Wheeler generators, transformers, switchyard, sources of auxiliary power, unit auxilaries, and starting of turbines by direct control.

TRANSMISSION PLANT

Step-up transformers:
3 banks of 3 single-phase, 2-winding transformers, banks 1, 2, and 4; each bank rated 13.2-154 kV, 72,000 kVA self-cooled, 84,000 kVA forced-air-cooled; Westinghouse
1 bank of 3 single-phase, 2-winding transformers, bank 3; bank rated 13.2-161 kV, 63,000 kVA self-cooled, 84,000 kVA forced-air-cooled; Moloney
1 bank of 3 single-phase, 2-winding transformers, bank 5; bank rated 13.2-161 kV, 126,000 kVA forced-aircooled; Penn Transformer Co.
Untanking crane:
1 175-ton indoor overhead
161-kV circuit breakers:
10 1200-A, 7,500,000-kVA, 3/20-Hz, pneu, Westinghouse
2 1200-A, 7,500,000-kVA, 3/20-Hz, pneu, General Electric

Structures:
13 161-kV switchyard bays, 32 ft wide
5 transformer structures
Bank 5 terminates in bay 10.
Banks 3 and 4 are in parallel and terminate in bay 6.
Banks 1 and 2 are in parallel and terminate in bay 1.
Bay 4 is available as a future line bay.

(See Figure 19 for single line diagram of main connections)

(See Figure 20 for view of switchyard)

FIGURE 19 - Single Line Diagram of Main Connections

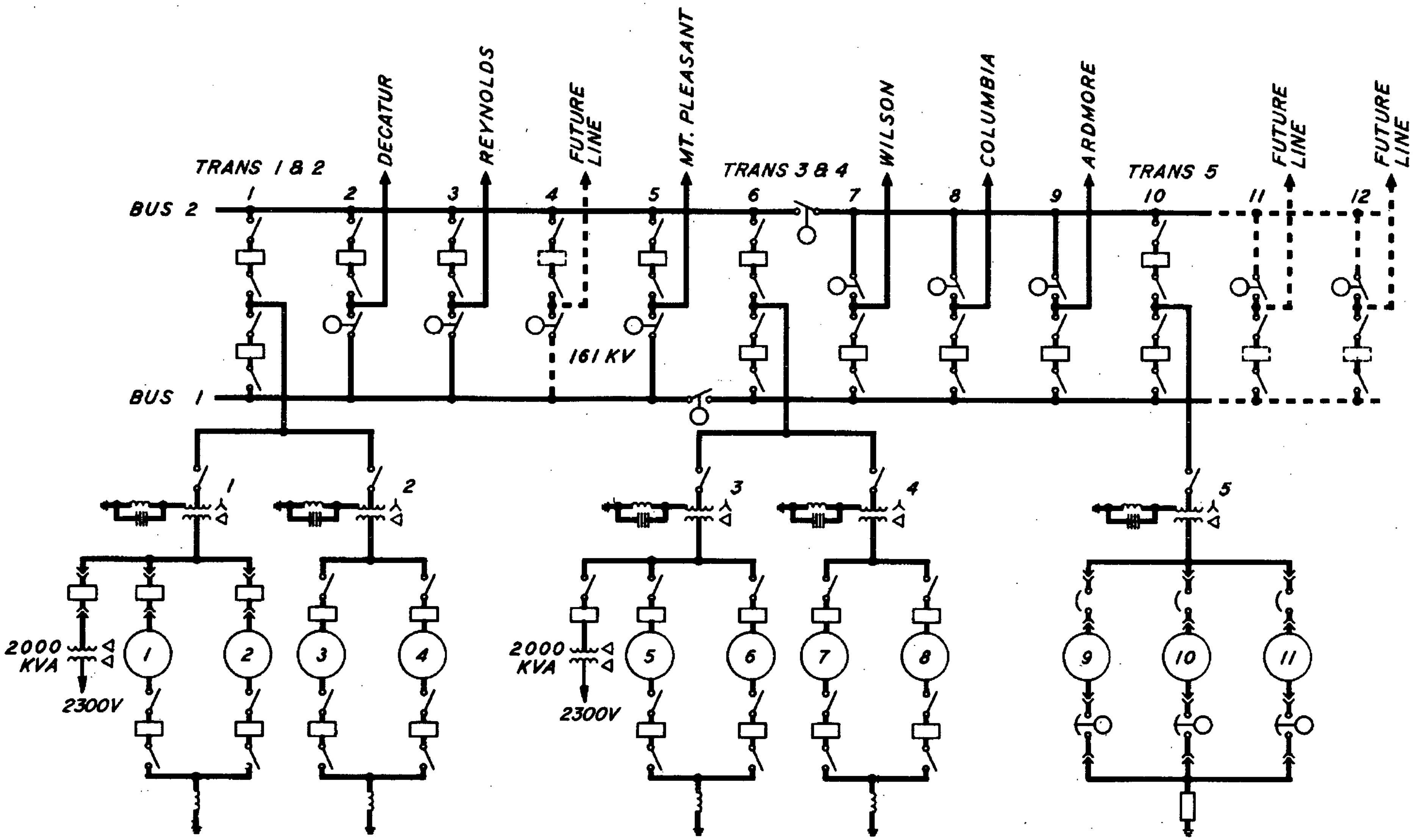
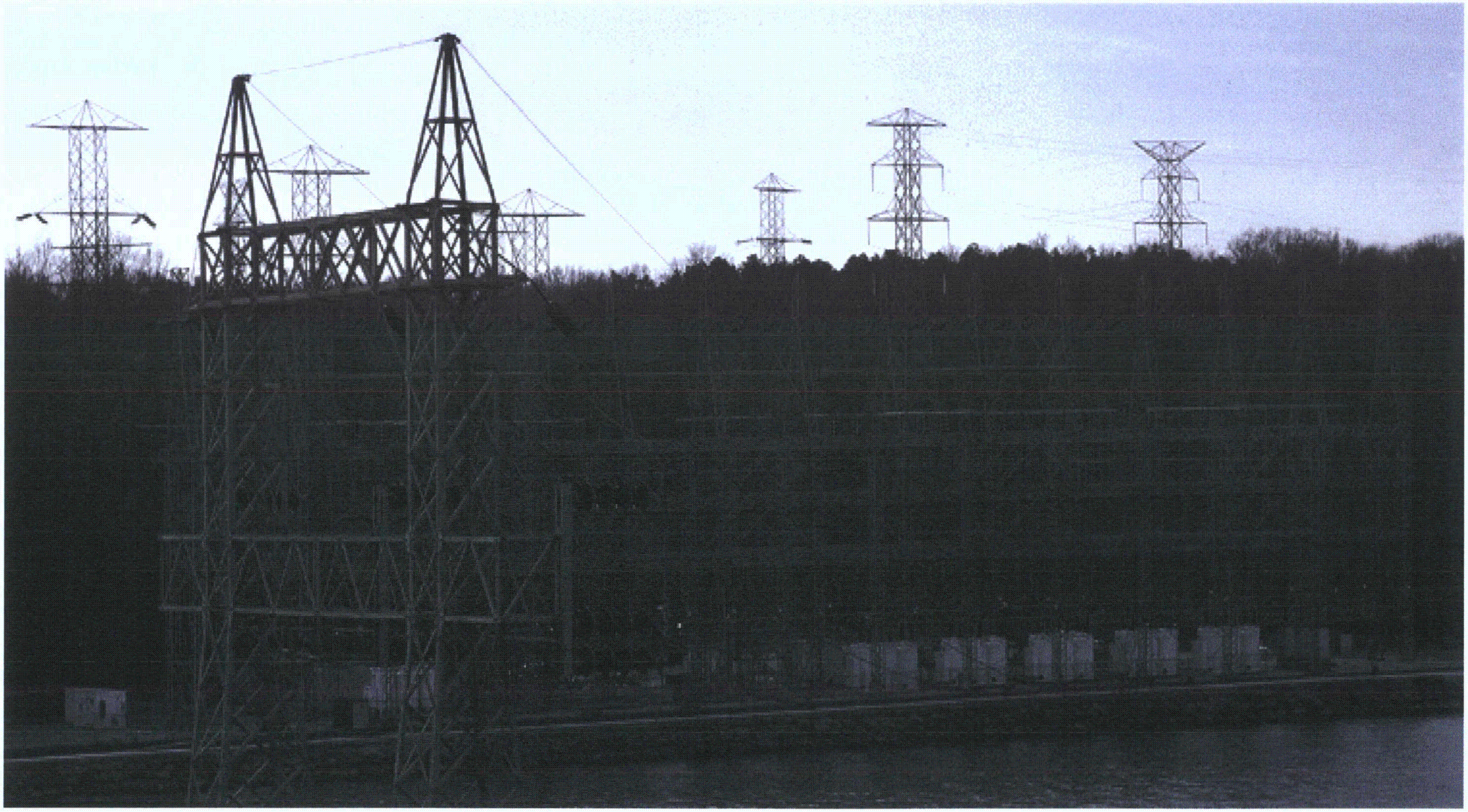


FIGURE 20 - Switchyard, February 2000



TRANSMISSION PLANT DATA

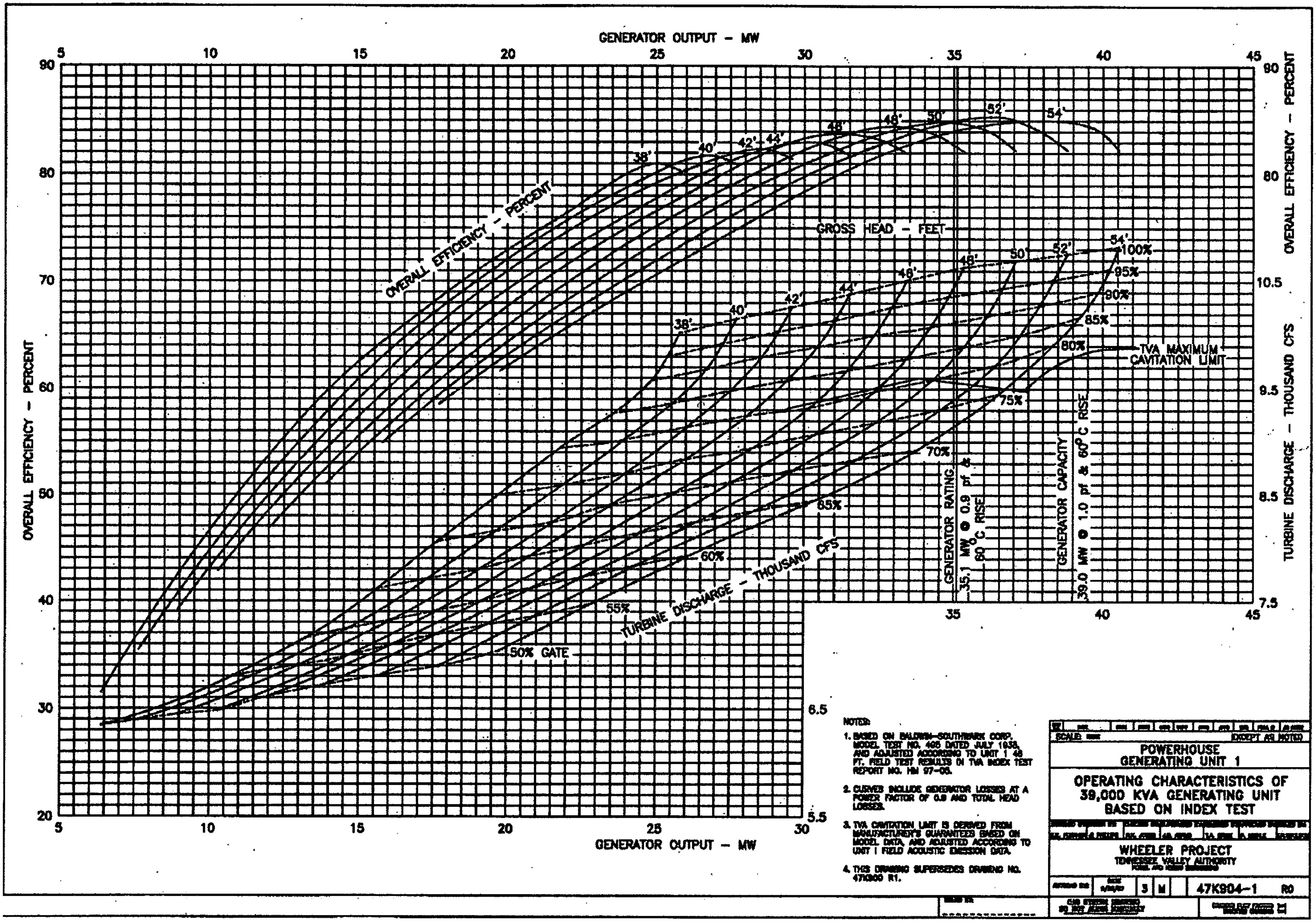
Plant	Location	Phase	Serial Number	MVA Rating		Voltage kV	Cooling	Tap Changer	Oil Preservation System	Oil Volume Gal.	Configuration	Impedance %			Contract Number	Manufacturer	Yr of Manuf
				55 deg	65 deg							H-X	H-Y	X-Y			
Wheeler	Bank 1	A	2070869	24/28	N/A	154/13.2	OA/FA	DETC	Gas-Blanketed	5110	Wye/Delta	8.62	N/A	N/A	TV-1443	Westinghouse	1935
Wheeler	Bank 1	B	2070871	24/28	N/A	154/13.2	OA/FA	DETC	Gas-Blanketed	5110	Wye/Delta	8.62	N/A	N/A	TV-1443	Westinghouse	1935
Wheeler	Bank 1	C	2070870	24/28	N/A	154/13.2	OA/FA	DETC	Gas-Blanketed	5110	Wye/Delta	8.62	N/A	N/A	TV-1443	Westinghouse	1935
Wheeler	Bank 2	A	2490839	24/28	N/A	154/13.2	OA/FA	DETC	Gas-Blanketed	5110	Wye/Delta	8.53	N/A	N/A	TV-53003	Westinghouse	1939
Wheeler	Bank 2	B	2781149	24/28	N/A	154/13.2	OA/FA	DETC	Gas-Blanketed	5110	Wye/Delta	8.58	N/A	N/A	TV-53003	Westinghouse	1940
Wheeler	Bank 2	C	2781150	24/28	N/A	154/13.2	OA/FA	DETC	Gas-Blanketed	5110	Wye/Delta	8.56	N/A	N/A	TV-53003	Westinghouse	1940
Wheeler	Bank 3	A	773083	21/28	N/A	161/13.2	OA/FA	DETC	Gas-Blanketed	7884	Wye/Delta	12.73	N/A	N/A	TV-65261	Moloney	1945
Wheeler	Bank 3	B	773085	21/28	N/A	161/13.2	OA/FA	DETC	Gas-Blanketed	7884	Wye/Delta	12.77	N/A	N/A	TV-65261	Moloney	1945
Wheeler	Bank 3	C	773084	21/28	N/A	161/13.2	OA/FA	DETC	Gas-Blanketed	7884	Wye/Delta	12.75	N/A	N/A	TV-65261	Moloney	1945
Wheeler	Bank 4	A	4089007	24/28	N/A	154/13.2	OA/FA	DETC	Gas-Blanketed	5110	Wye/Delta	8.38	N/A	N/A	TV-98116	Westinghouse	1948
Wheeler	Bank 4	B	4089009	24/28	N/A	154/13.2	OA/FA	DETC	Gas-Blanketed	5110	Wye/Delta	8.40	N/A	N/A	TV-98116	Westinghouse	1948
Wheeler	Bank 4	C	4089008	24/28	N/A	154/13.2	OA/FA	DETC	Gas-Blanketed	5110	Wye/Delta	8.39	N/A	N/A	TV-98116	Westinghouse	1948
Wheeler	Bank 5	A	C0081551	42	N/A	161/13.2	FOA	DETC	Gas-Blanketed	2625	Wye/Delta	13.14	N/A	N/A	61L2-40486-1	Pennsylvania	1962
Wheeler	Bank 5	B	C0081553	42	N/A	161/13.2	FOA	DETC	Gas-Blanketed	2625	Wye/Delta	13.14	N/A	N/A	61L2-40486-1	Pennsylvania	1962
Wheeler	Bank 5	C	C0081552	42	N/A	161/13.2	FOA	DETC	Gas-Blanketed	2625	Wye/Delta	13.14	N/A	N/A	61L2-40486-1	Pennsylvania	1962

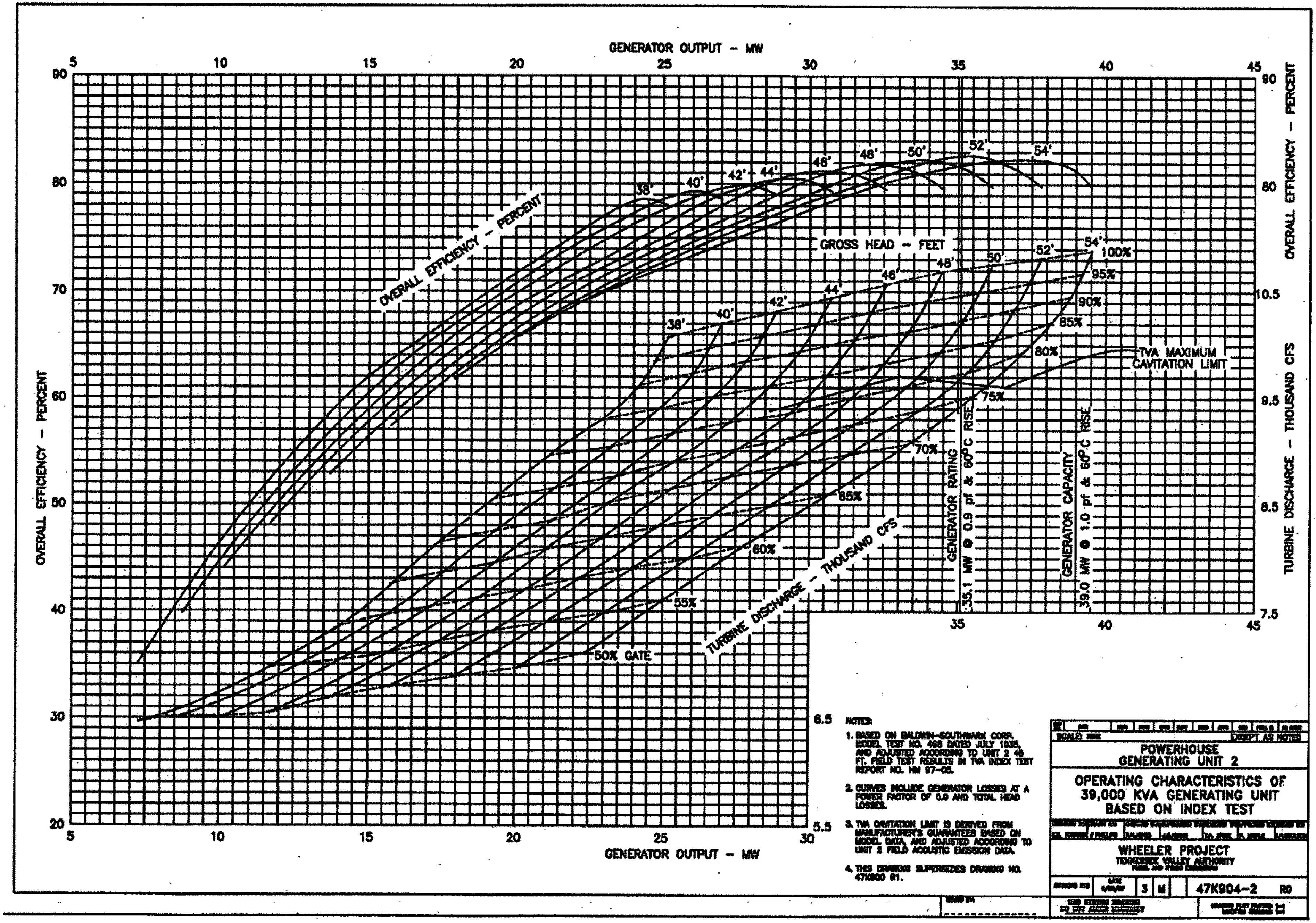
Note: H=High voltage winding
Y=Tertiary winding
X=Low voltage winding

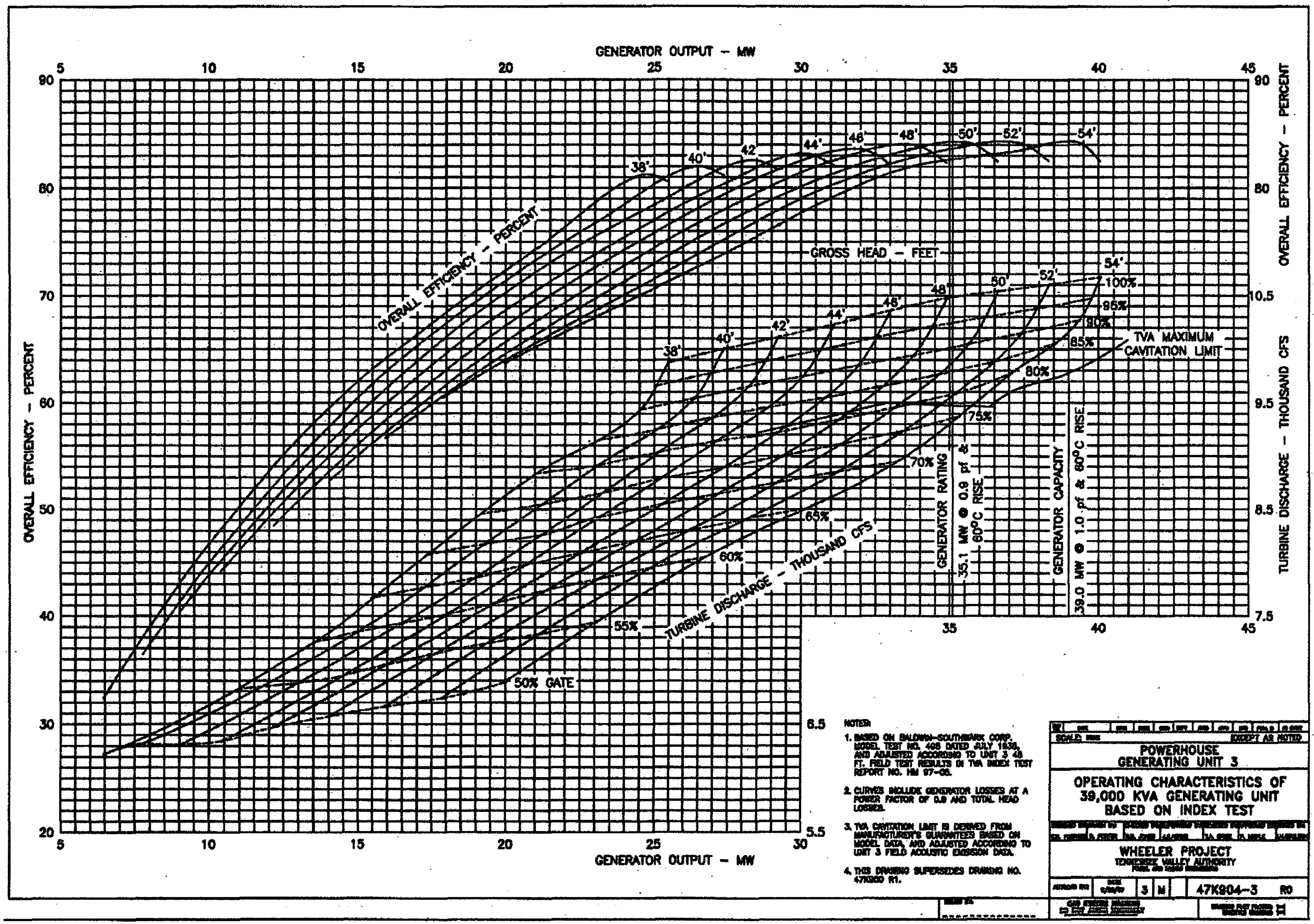
RESERVOIR AND POWER DATA

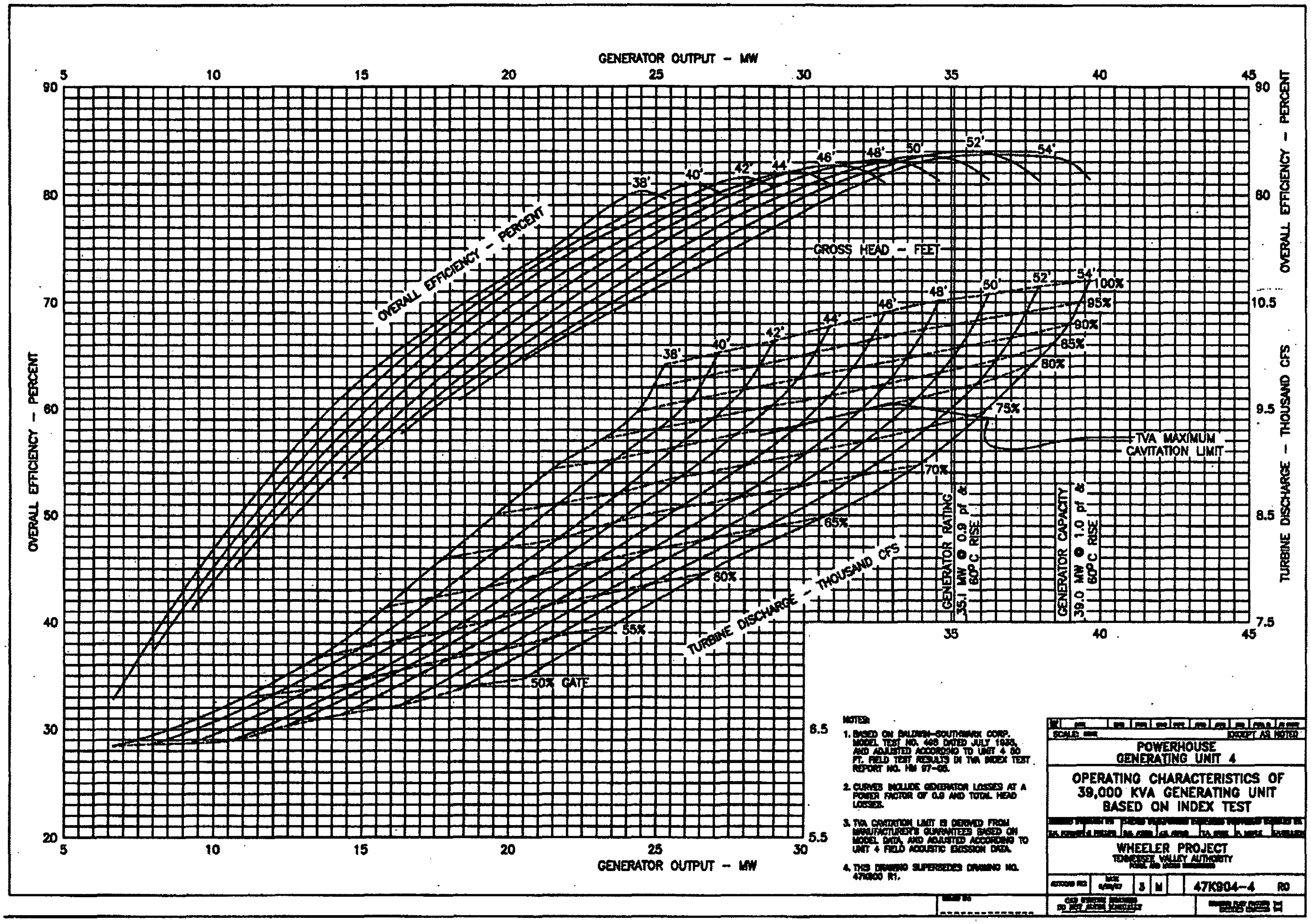
Wheeler

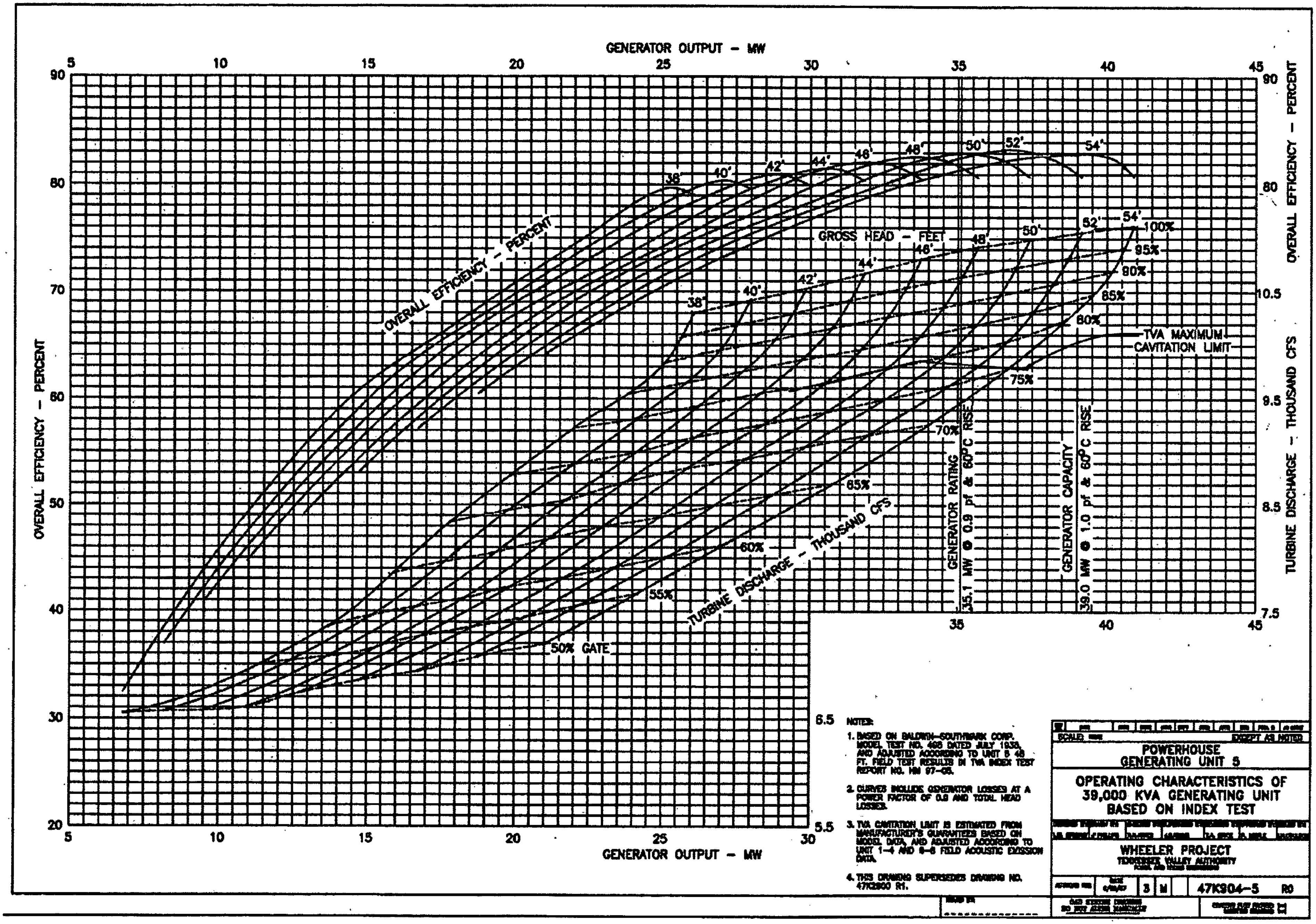
Elevation (feet)	Tailwater (feet)	Area (acre*1000)	Volume (ac-ft*1000)	Potential Eis (gWh)	Gross Head (feet)	Best Efficiency Plant Output (mW)	Best Efficiency Turbine Discharge (cfs)	Best Efficiency kW/CFS	Maximum Sustainable Plant Output (mW)	Maximum Sustainable Turbine Discharge (cfs)	Maximum Sustainable kW/CFS
557	507.5	72.51	1120.1	76.4	49.5	339.4	99,000	3.44	383.3	114,570	3.36
556	507.5	67.66	1050.0	62.7	48.5	339.8	101,000	3.37	383.4	116,860	3.29
555	507.5	62.88	984.7	50.1	47.5	336.1	101,880	3.30	377.9	117,440	3.22
554	507.5	58.47	924.1	38.4	46.5	328.3	101,630	3.23	366.6	116,310	3.15
553	507.5	54.44	867.7	27.7	45.5	320.5	101,380	3.16	355.3	115,190	3.08
552	507.5	50.78	815.1	17.7	44.5	312.7	101,130	3.09	344.1	114,060	3.01
551	507.5	47.50	766.0	8.5	43.5	304.8	100,880	3.02	332.8	112,940	2.94
550	507.5	44.58	720.0	.0	42.5	297.0	100,630	2.95	321.6	111,810	2.87

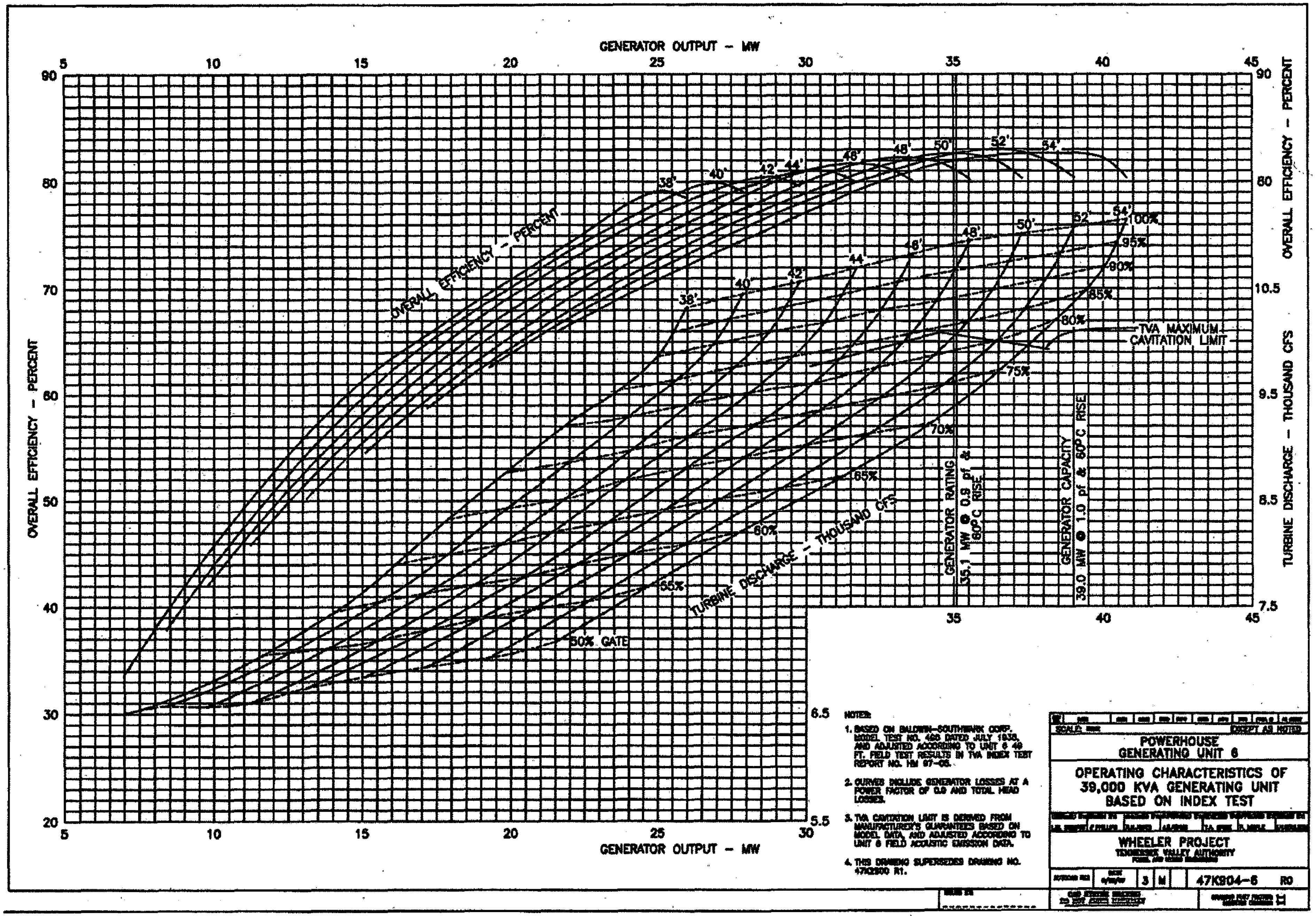

GENERATOR OUTPUT - MW
OVERALL EFFICIENCY - PERCENT
TURBINE DISCHARGE - THOUSAND CFS
GROSS HEAD - FEET
38'
40'
42'
44'
46'
48'
50'
52'
54'
100%
95%
90%
85%
80%
75%
70%
65%
60%
55%
50% GATE
TVA MAXIMUM CAVITATION LIMIT
GENERATOR RATING 35.1 MW @ 0.9 pf & 60°C RISE
GENERATOR CAPACITY 39.0 MW @ 1.0 pf & 60°C RISE
NOTES:
1. BASED ON BALDWIN-SOUTHWARK CORP. MODEL TEST NO. 495 DATED JULY 1938, AND ADJUSTED ACCORDING TO UNIT 1 48 FT. FIELD TEST RESULTS IN TVA INDEX TEST REPORT NO. HM 97-05.
2. CURVES INCLUDE GENERATOR LOSSES AT A POWER FACTOR OF 0.9 AND TOTAL HEAD LOSSES.
3. TVA CAVITATION LIMIT IS DERIVED FROM MANUFACTURER'S GUARANTEES BASED ON MODEL DATA, AND ADJUSTED ACCORDING TO UNIT I FIELD ACOUSTIC EMISSION DATA.
4. THIS DRAWING SUPERSEDES DRAWING NO. 47K900 R1.
SCALE: EXCEPT AS NOTED
POWERHOUSE GENERATING UNIT 1
OPERATING CHARACTERISTICS OF 39,000 KVA GENERATING UNIT BASED ON INDEX TEST
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
3
M
47K904-1
R0

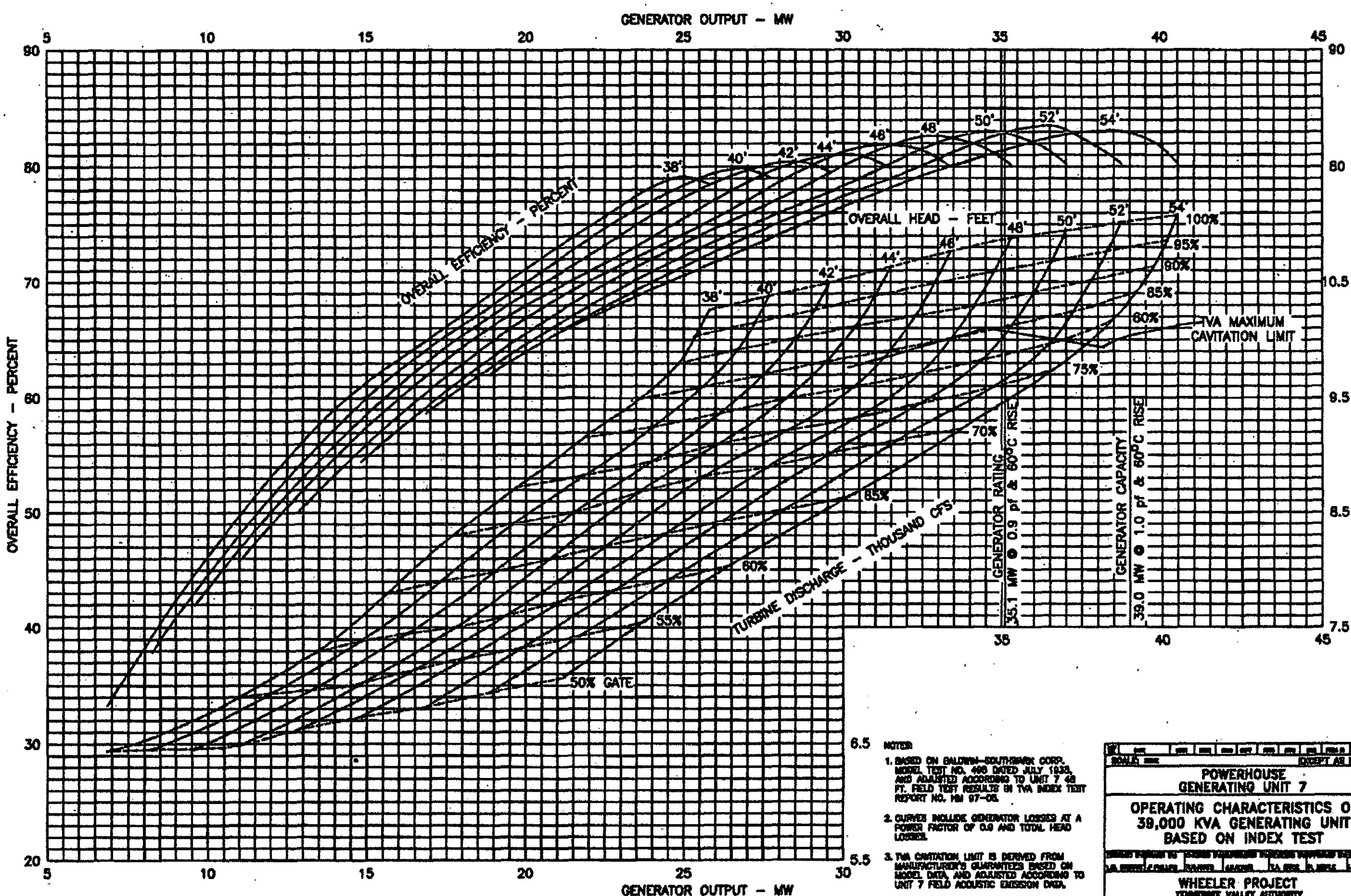

GENERATOR OUTPUT – MW
OVERALL EFFICIENCY – PERCENT
TURBINE DISCHARGE – THOUSAND CFS
OVERALL EFFICIENCY – PERCENT
GROSS HEAD – FEET
TURBINE DISCHARGE – THOUSAND CFS
50% GATE
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
TVA MAXIMUM CAVITATION LIMIT
35.1 MW @ 0.9 pf & 60°C RISE GENERATOR RATING
39.0 MW @ 1.0 pf & 60°C RISE GENERATOR CAPACITY
NOTES:
1. BASED ON BALDWIN-SOUTHWARK CORP. MODEL TEST NO. 486 DATED JULY 1935, AND ADJUSTED ACCORDING TO UNIT 2 48 FT. FIELD TEST RESULTS IN TVA INDEX TEST REPORT NO. HM 97-05.
2. CURVES INCLUDE GENERATOR LOSSES AT A POWER FACTOR OF 0.9 AND TOTAL HEAD LOSSES.
3. TVA CAVITATION LIMIT IS DERIVED FROM MANUFACTURER'S GUARANTEES BASED ON MODEL DATA, AND ADJUSTED ACCORDING TO UNIT 2 FIELD ACOUSTIC EMISSION DATA.
4. THIS DRAWING SUPERSEDES DRAWING NO. 47K900 R1.
EXCEPT AS NOTED
POWERHOUSE
GENERATING UNIT 2
OPERATING CHARACTERISTICS OF
39,000 KVA GENERATING UNIT
BASED ON INDEX TEST
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
47K904-2 R0


GENERATOR OUTPUT – MW
OVERALL EFFICIENCY – PERCENT
TURBINE DISCHARGE – THOUSAND CFS
GROSS HEAD – FEET
38' 40' 42' 44' 46' 48' 50' 52' 54'
100% 95% 90% 85% 80% 75% 70% 65% 60% 55% 50% GATE
TVA MAXIMUM CAVITATION LIMIT
GENERATOR RATING 35.1 MW @ 0.9 pf & 60°C RISE
GENERATOR CAPACITY 39.0 MW @ 1.0 pf & 60°C RISE
NOTES:
1. BASED ON BALDWIN-SOUTHWARK CORP. MODEL TEST NO. 498 DATED JULY 1938, AND ADJUSTED ACCORDING TO UNIT 3 48 FT. FIELD TEST RESULTS IN TVA INDEX TEST REPORT NO. HM 97-06.
2. CURVES INCLUDE GENERATOR LOSSES AT A POWER FACTOR OF 0.9 AND TOTAL HEAD LOSSES.
3. TVA CAVITATION LIMIT IS DERIVED FROM MANUFACTURER'S GUARANTEES BASED ON MODEL DATA, AND ADJUSTED ACCORDING TO UNIT 3 FIELD ACOUSTIC EMISSION DATA.
4. THIS DRAWING SUPERSEDES DRAWING NO.
EXCEPT AS NOTED
POWERHOUSE GENERATING UNIT 3
OPERATING CHARACTERISTICS OF 39,000 KVA GENERATING UNIT BASED ON INDEX TEST
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
47K904-3 R0


GENERATOR OUTPUT - MW
OVERALL EFFICIENCY - PERCENT
OVERALL EFFICIENCY - PERCENT
TURBINE DISCHARGE - THOUSAND CFS
GROSS HEAD - FEET
TURBINE DISCHARGE - THOUSAND CFS
38' 40' 42' 44' 46' 48' 50' 52' 54'
100% 95% 90% 85% 80% 75% 70% 65% 60% 55% 50% GATE
TVA MAXIMUM CAVITATION LIMIT
GENERATOR RATING 35.1 MW @ 0.9 pf & 60°C RISE
GENERATOR CAPACITY 39.0 MW @ 1.0 pf & 60°C RISE
NOTES:
2. CURVES INCLUDE GENERATOR LOSSES AT A POWER FACTOR OF 0.9 AND TOTAL HEAD LOSSES.
3. TVA CAVITATION LIMIT IS DERIVED FROM MANUFACTURER'S GUARANTEES BASED ON MODEL DATA, AND ADJUSTED ACCORDING TO UNIT 4 FIELD ACOUSTIC EMISSION DATA.
4. THIS DRAWING SUPERSEDES DRAWING NO.
EXCEPT AS NOTED
POWERHOUSE
GENERATING UNIT 4
OPERATING CHARACTERISTICS OF
39,000 KVA GENERATING UNIT
BASED ON INDEX TEST
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
47K904-4 R0


GENERATOR OUTPUT – MW
OVERALL EFFICIENCY – PERCENT
TURBINE DISCHARGE – THOUSAND CFS
GROSS HEAD – FEET
38'
40'
42'
44'
46'
48'
50'
52'
54'
100%
95%
90%
85%
80%
75%
70%
65%
60%
55%
50% GATE
TVA MAXIMUM CAVITATION LIMIT
GENERATOR RATING 35.1 MW @ 0.9 pf & 60°C RISE
GENERATOR CAPACITY 39.0 MW @ 1.0 pf & 60°C RISE
NOTES:
1. BASED ON BALDWIN–SOUTHWARK CORP. MODEL TEST NO. 466 DATED JULY 1936, AND ADJUSTED ACCORDING TO UNIT 5 48 FT. FIELD TEST RESULTS IN TVA INDEX TEST REPORT NO. HM 97–05.
2. CURVES INCLUDE GENERATOR LOSSES AT A POWER FACTOR OF 0.9 AND TOTAL HEAD LOSSES.
3. TVA CAVITATION LIMIT IS ESTIMATED FROM MANUFACTURER'S GUARANTEES BASED ON MODEL DATA, AND ADJUSTED ACCORDING TO UNIT 1–4 AND 5–6 FIELD ACOUSTIC EMISSION DATA.
4. THIS DRAWING SUPERSEDES DRAWING NO. 47K2900 R1.
SCALE: EXCEPT AS NOTED
POWERHOUSE GENERATING UNIT 5
OPERATING CHARACTERISTICS OF 39,000 KVA GENERATING UNIT BASED ON INDEX TEST
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
3 M 47K904–5 R0


GENERATOR OUTPUT – MW
OVERALL EFFICIENCY – PERCENT
TURBINE DISCHARGE – THOUSAND CFS
OVERALL EFFICIENCY – PERCENT
TURBINE DISCHARGE – THOUSAND CFS
38' 40' 42' 44' 46' 48' 50' 52' 54'
100% 95% 90% 85% 80% 75% 70% 65% 60% 55% 50% GATE
TVA MAXIMUM CAVITATION LIMIT
GENERATOR RATING 35.1 MW @ 0.9 pf & 60°C RISE
GENERATOR CAPACITY 39.0 MW @ 1.0 pf & 60°C RISE
NOTES:
1. BASED ON BALDWIN-SOUTHWARK CORP. MODEL TEST NO. 460 DATED JULY 1935, AND ADJUSTED ACCORDING TO UNIT 6 49 FT. FIELD TEST RESULTS IN TVA INDEX TEST REPORT NO. HM 97-05.
2. CURVES INCLUDE GENERATOR LOSSES AT A POWER FACTOR OF 0.9 AND TOTAL HEAD LOSSES.
3. TVA CAVITATION LIMIT IS DERIVED FROM MANUFACTURER'S GUARANTEES BASED ON MODEL DATA, AND ADJUSTED ACCORDING TO UNIT 6 FIELD ACOUSTIC EMISSION DATA.
4. THIS DRAWING SUPERSEDES DRAWING NO. 47K2800 R1.
EXCEPT AS NOTED
POWERHOUSE
GENERATING UNIT 6
OPERATING CHARACTERISTICS OF
39,000 KVA GENERATING UNIT
BASED ON INDEX TEST
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
47K904-6 R0



NOTES:

1. BASED ON BALDWIN-SOUTHWARK CORP. MODEL TEST NO. 496 DATED JULY 1935, AND ADJUSTED ACCORDING TO UNIT 7 48 FT. FIELD TEST RESULTS IN TVA INDEX TEST REPORT NO. HM 97-06.
2. CURVES INCLUDE GENERATOR LOSSES AT A POWER FACTOR OF 0.9 AND TOTAL HEAD LOSSES.
3. TVA CAVITATION LIMIT IS DERIVED FROM MANUFACTURER'S GUARANTEES BASED ON MODEL DATA, AND ADJUSTED ACCORDING TO UNIT 7 FIELD ACOUSTIC EMISSION DATA.
4. THIS DRAWING SUPERSEDES DRAWING NO. 47K0900 R1.

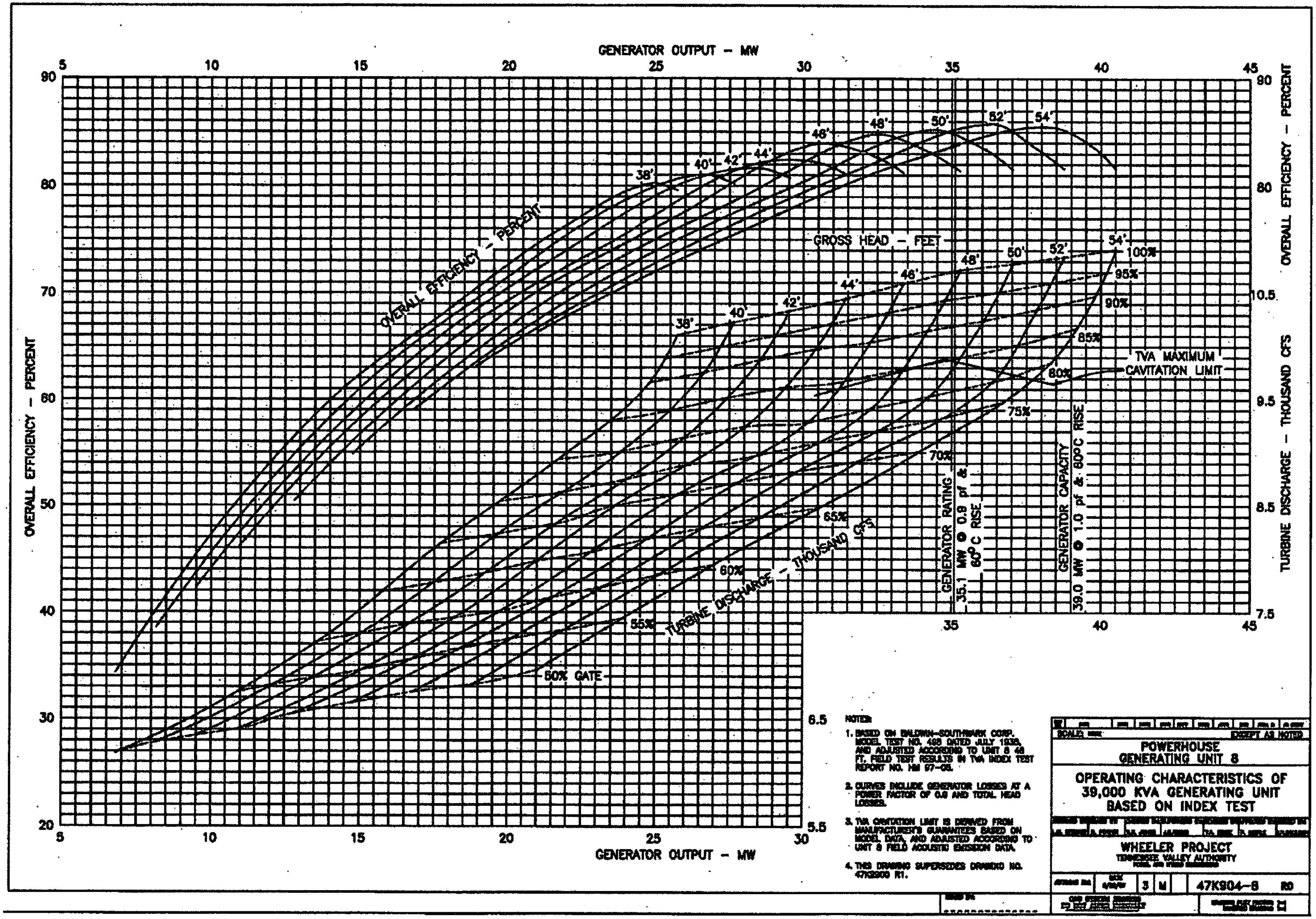
SCALE: NONE EXCEPT AS NOTED

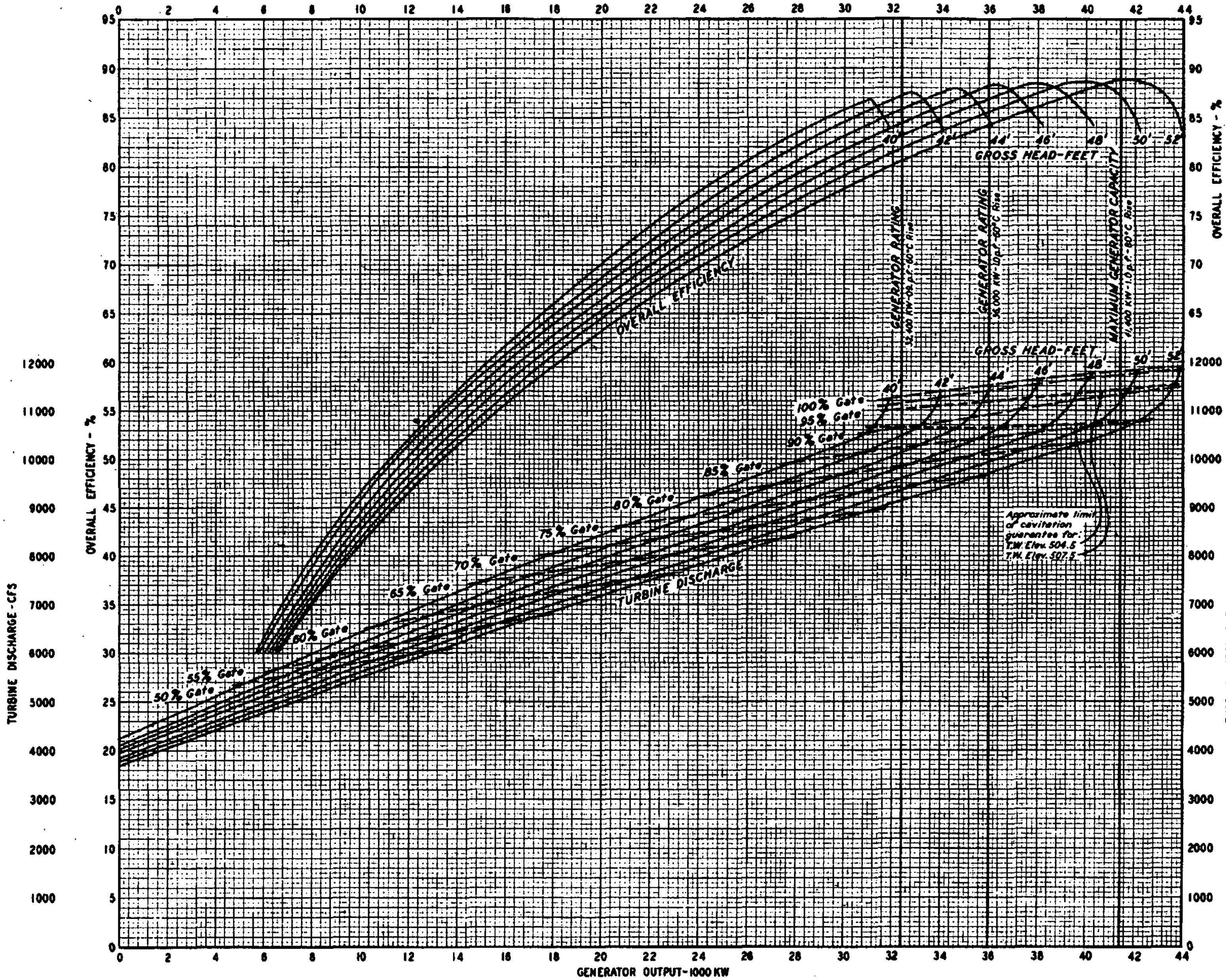
POWERHOUSE
GENERATING UNIT 7

OPERATING CHARACTERISTICS OF
39,000 KVA GENERATING UNIT
BASED ON INDEX TEST

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY

3 M 47K904-7 R0


GENERATOR OUTPUT – MW
OVERALL EFFICIENCY – PERCENT
TURBINE DISCHARGE – THOUSAND CFS
OVERALL EFFICIENCY – PERCENT
GROSS HEAD – FEET
38' 40' 42' 44' 46' 48' 50' 52' 54'
100% 95% 90% 85% 80% 75% 70% 65% 60% 55% 50% GATE
TVA MAXIMUM CAVITATION LIMIT
TURBINE DISCHARGE – THOUSAND CFS
GENERATOR RATING 35.1 MW @ 0.9 pf & 60° C RISE
GENERATOR CAPACITY 39.0 MW @ 1.0 pf & 60° C RISE
NOTES:
1. BASED ON BALDWIN-SOUTHWARK CORP. MODEL TEST NO. 495 DATED JULY 1938, AND ADJUSTED ACCORDING TO UNIT 8 48 FT. FIELD TEST RESULTS IN TVA INDEX TEST REPORT NO. HM 97-05.
2. CURVES INCLUDE GENERATOR LOSSES AT A POWER FACTOR OF 0.9 AND TOTAL HEAD LOSSES.
3. TVA CAVITATION LIMIT IS DERIVED FROM MANUFACTURER'S GUARANTEES BASED ON MODEL DATA, AND ADJUSTED ACCORDING TO UNIT 8 FIELD ACOUSTIC EMISSION DATA.
4. THIS DRAWING SUPERSEDES DRAWING NO. 47K2900 R1.
SCALE: EXCEPT AS NOTED
POWERHOUSE GENERATING UNIT 8
OPERATING CHARACTERISTICS OF 39,000 KVA GENERATING UNIT BASED ON INDEX TEST
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
47K904-8



Curves are based on Baldwin-Lima-Hamilton Corporation model test No.81 series, calculated generator losses, and calculated intake and draft tube losses. These curves will be revised after field tests.

PRELIMINARY
UNITS 9 - 11

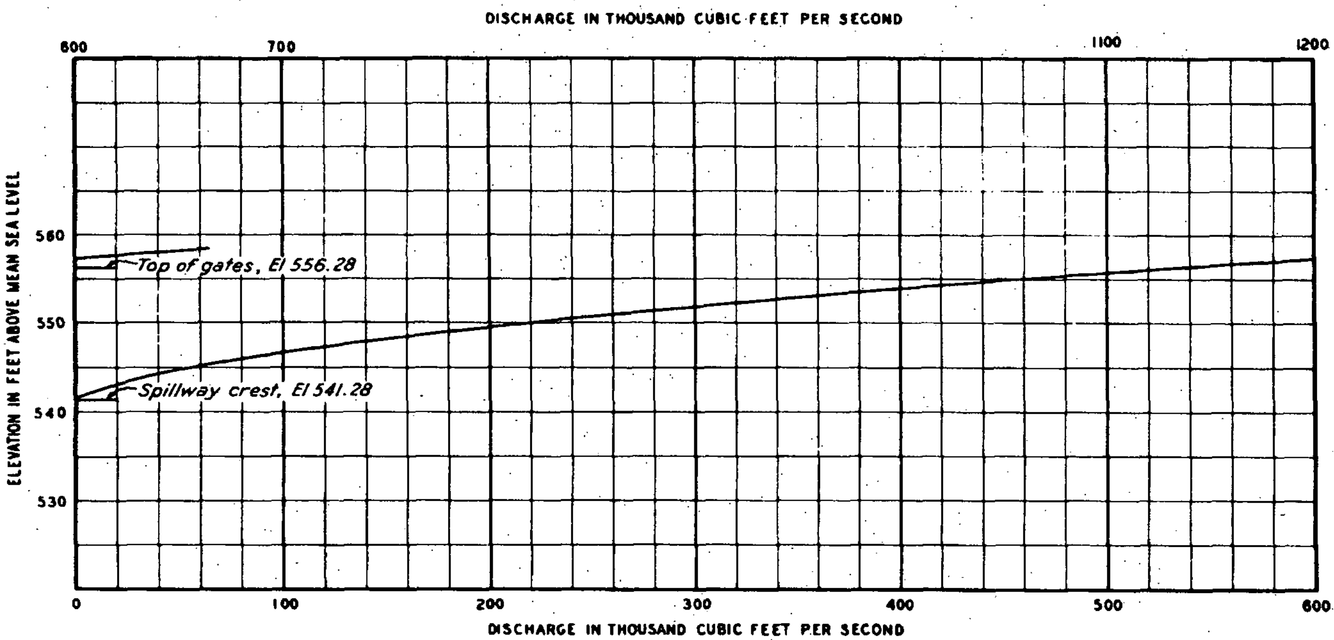
OPERATING CHARACTERISTICS OF 36,000 KVA UNITS BASED ON MODEL TEST

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF DESIGN

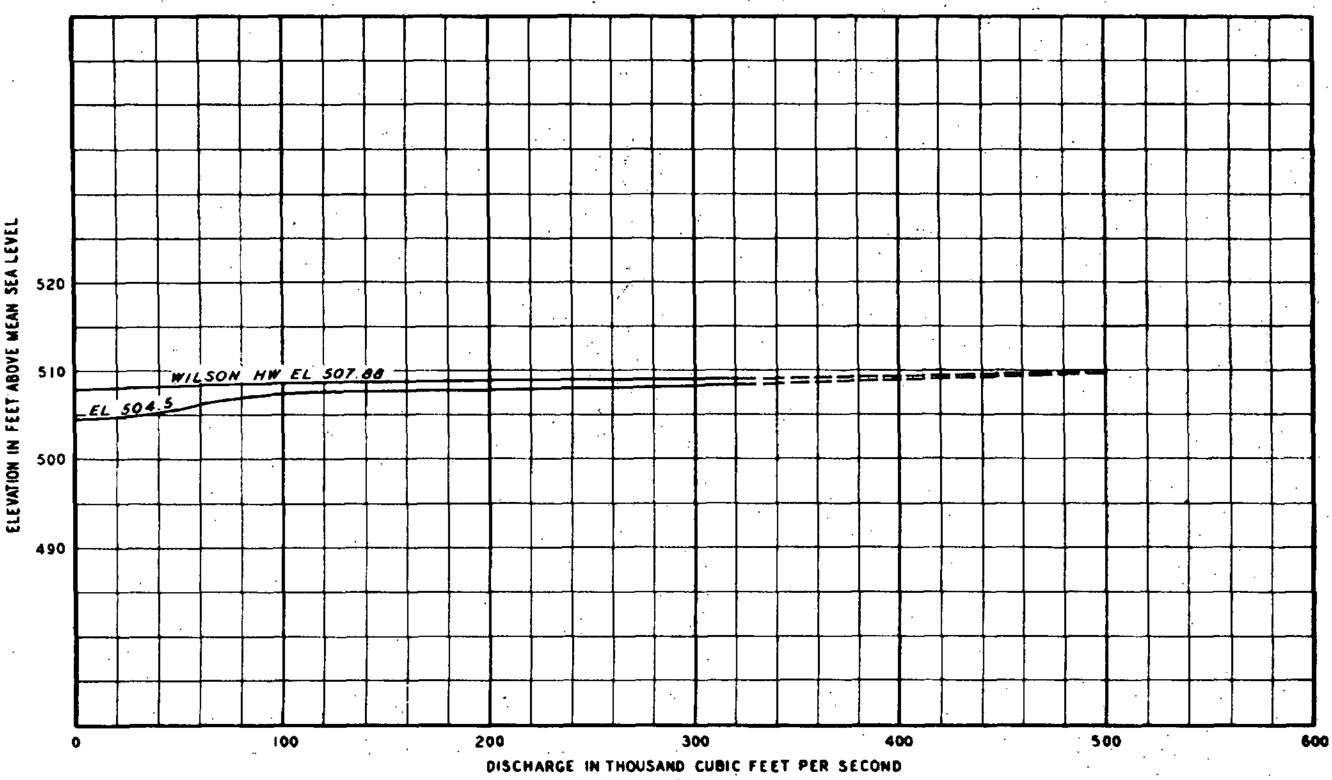
SUBMITTED	RECOMMENDED	APPROVED
[signature]	[signature]	W. F. Emmons

KNOXVILLE 6-5-61 3 M 4 47K4901 R0

TENNESSEE VALLEY AUTHORITY

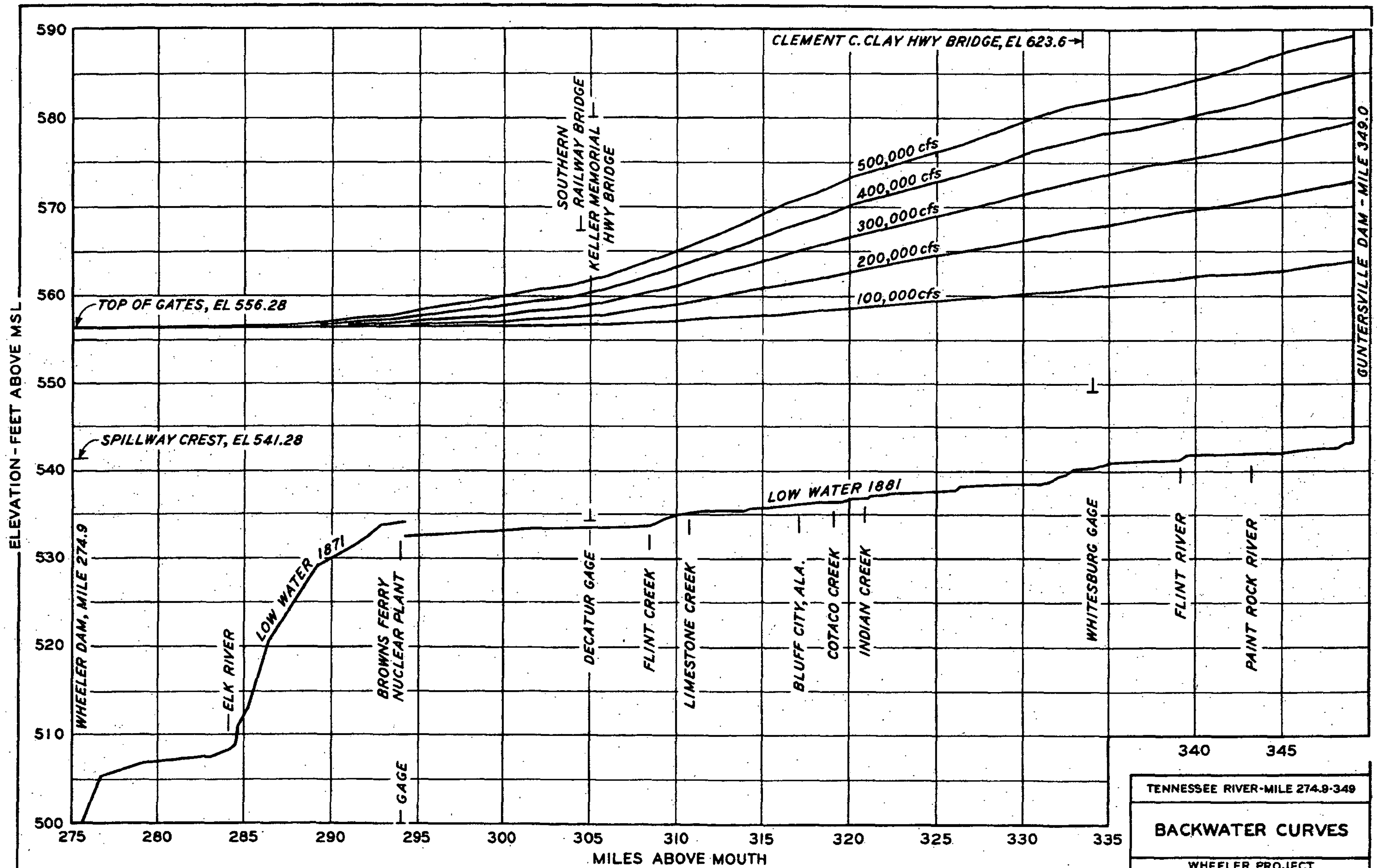


HEADWATER RATING CURVE



TAILWATER RATING CURVE

WHEELER DAM



TENNESSEE RIVER-MILE 274.9-349

BACKWATER CURVES

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

SUBMITTED	RECOMMENDED	APPROVED
E.A. Gillett	[signature]	R.C. Elliott

KNOXVILLE 8-3-72 3 FC 1 3218871 R

YEAR	MAXIMUM AVERAGE DAILY DISCHARGE (TURBINE + SPILL)	DATE	NUMBER OF PERIODS	TOTAL DAYS	Volumes are average daily in day-second-feet. except as shown. Maximum spill, date of maximum, and number of days of spill in each spill period, in this order. "Total Days" is for calendar year and does not always equal the sum of the days in periods because of extension of periods into adjacent years. All spill is through the spillway. Maximum hourly average discharge to date was 411,900 cfs at 7 p.m. on 3/18/73. *Instantaneous values from monthly report graphs (approximate).
1936	*82000	12/10	0	52	
1937	*240000	1/7	1	361	240000---1/7---251
1938	*174000	4/12	4	352	167000---4/12---416; 13000---9/14---5; 14000---9/22---5; 48000---10/4---7; 62000---12/31---101
1939	*289000	2/17	9	226	280000---2/17---152; 20000---7/4---9; 44000---7/11---14; 8000---7/27---5; 15000---8/8---9; 5000---8/14---2 4000---8/19---2; 11000---8/28---9; 8000---9/7---4
1940	*109000	3/16	19	230	91000---2/21---97; 31156---7/11---20; 8645---8/5---5; 5667---8/10---3; 45436---9/3---38; 9305---9/21---3; 8856---9/27---4; 4091---10/1---6; 7459---10/9---4; 4577---10/8---8; 3546---10/25---3; 1926---10/31---5; 5733---11/7---4; 3647---11/12---1; 5182---11/15---2; 8083---11/22---6; 6126---11/27---5; 5324---12/11---13; 5936---12/19---11
1941	74959	4/6	8	52	47045---1/4---14; 1611---1/16---1; 18013---3/16---3; 9993---3/21---3; 9275---3/29---3; 47086---4/6---16; 29011---7/12---12; 5754---8/1---2
1942	244564	12/31	6	72	35285---2/18---4; 13584---2/25---5; 82350---3/22---18; 16967---3/29---3; 12874---4/14---3; 32604---8/26---12
1943	269752	1/2	6	92	232067---1/2---50; 128118---2/10---27; 82887---3/22---18; 8225---4/3---2; 51200---4/24---17; 12400---5/12---5
1944	288285	3/31	5	95	22756---1/5---4; 132600---3/1---38; 81617---3/21---7; 249243---3/31---11; 92973---4/14---31
1945	188675	2/20	8	133	93662---1/2---31; 149950---2/20---33; 18354---3/30---9; 9104---4/6---3; 60850---4/29---8; 48208---5/15---16; 15367---6/21---7; 16892---11/24---2
1946	331208	1/12	11	149	293333---1/12---92; 75408---3/11---19; 12417---4/1---6; 18700---4/11---3; 12283---5/5---4; 74671---5/18---9; 12688---6/6---4; 13792---6/16---2; 7900---7/11---3; 41288---11/18---13; 13725---11/27---12
1947	276142	1/20	4	93	237896---1/20---56; 62400---3/11--36; 18737---4/15---6; 3800---12/18---6
1948	320871	2/16	2	118	282650---2/16---79; 17183---11/23---2
1949	321517	1/8	11	127	273867---1/8---93; 9029---3/2---4; 58658---4/1---10; 31833---5/2---5; 15158---6/16---2; 2025---6/21---1; 80512---7/19---9; 18658---7/24---2; 61283---11/3---9; 11854---12/4---8; 68900---12/26---21
1950	234987	2/5	5	73	171558---2/5---54; 153142---3/16---9; 19271---9/12---5; 9629---12/7---4; 425---4/19---1
1951	254800	3/30	7	49	133217---2/4---11; 31571---2/23---5; 1971---3/11---1; 179000---3/30---7; 12000---4/22---2; 21500---12/9&10---5; 116000---12/26---20
1952	180400	3/13	5	42	43800---1/12---5; 65700---1/30---18; 11500---3/5---3; 103800---3/13---7; 71800---3/24---7

Wheeler Spill Compilation

Tennessee Valley Authority
River System Operations

YEAR	MAXIMUM AVERAGE DAILY DISCHARGE (TURBINE + SPILL)	DATE	NUMBER OF PERIODS	TOTAL DAYS	Volumes are average daily in day-second-feet. except as shown. Maximum spill, date of maximum, and number of days of spill in each spill period, in this order. "Total Days" is for calendar year and does not always equal the sum of the days in periods because of extension of periods into adjacent years. All spill is through the spillway. Maximum hourly average discharge to date was 411,900 cfs at 7 p.m. on 3/18/73. *Instantaneous values from monthly report graphs (approximate).
1953	177800	2/24	4	30	22100---1/12---3; 101100---2/24---17; 46500---3/7---8; 6400---5/4---2
1954	271200	1/25	1	18	193400---1/25---15
1955	242400	3/23	5	21	37600---1/1---6; 40200---2/10---3; 42100---2/24---3; 164700---3/23---10; 7900---4/7---2
1956	242500	2/5	6	37	166100---2/5---10; 67600---2/21---9; 64700---3/17---6; 14500---4/6---2; 30500---4/17---4; 73700---12/14---6
1957	345300	2/4	6	72	269100---2/4---28; 16300---3/1---6; 8700---4/8---2; 222700---11/21---16; 82800---12/10---8; 74200---12/24---14
1958	170600	5/1	4	22	24700---2/8---5; 8600---4/27---2; 92800---5/1---5; 42200---5/11---8
1959	140900	12/23	4	20	54000---1/25---6; 12500---4/20---2; 32000---12/15---4; 64100---12/23---8
1960	141200	3/5	3	16	62000---1/10---2; 33600---2/2---5; 63600---3/5---9
1961	263800	12/20	4	50	159300---2/28---13; 155600---3/11---11; 51000---6/4---5; 188200---12/20---22
1962	292000	2/28	6	60	40500---1/7---5; 187000---2/1---15; 214600---2/28---24; 11000---3/26---4; 22800---4/1---2; 106200---4/13---9
1963	328700	3/16	5	103	243800---3/16---21; 99900---5/1---6; 13100---6/30---10; 28600---7/23---59; 9200---9/7---7
1964	222300	3/16	4	34	111900---3/16---6; 42500---3/27---6; 74800---4/9---13; 31200---4/30---9
1965	303200	3/30	3	20	14200---1/13---3; 35700---2/14---6; 189000---3/30---11
1966	164100	2/16	1	6	50600---2/16---6
1967	220600	12/23	3	24	28400---3/10---4; 17300---7/13---6; 112800---12/23---32
1968	224800	1/12	0	18	
1969	226500	2/5	2	12	15100---1/21---2; 119700---2/4---8
1970	243400	1/3	4	17	132700---1/3---8; 22200---4/4---4; 1000---4/8---1; 55500---4/27---6
1971	153300	3/2	3	19	33000---1/26---5; 39500---3/2---11; 22400---12/10---3
1972	207800	12/16	3	39	49700---1/15---15; 19500---3/6---5; 94600---12/16---18
1973	410800	3/18	5	55	29900---1/5---12; 30100---2/15---4; 296600---3/18---19; 82000---5/30---8; 43500---12/1---7
1974	272300	1/13	4	67	159300--1/13---64; 18500---3/24---4; 4400---4/5---1; 4300---4/7---2

Wheeler Spill Compilation

YEAR	MAXIMUM AVERAGE DAILY DISCHARGE (TURBINE + SPILL)	DATE	NUMBER OF PERIODS	TOTAL DAYS	Volumes are average daily in day-second-feet. except as shown. Maximum spill, date of maximum, and number of days of spill in each spill period, in this order. "Total Days" is for calendar year and does not always equal the sum of the days in periods because of extension of periods into adjacent years. All spill is through the spillway. Maximum hourly average discharge to date was 411,900 cfs at 7 p.m. on 3/18/73. *Instantaneous values from monthly report graphs (approximate).
1975	288500	3/16	7	54	20800---1/1---4; 8100---1/14---4; 14500---1/30---5; 13900---2/8---5; 35700---2/22---8; 176100---3/16---28;
1976	113300	1/4	0	0	
1977	260200	4/7	5	35	44300---3/15---5; 142800---4/7---8; 2700---4/16---1; 19800---11/8---4; 67200---11/30---17; 118000---10/17---2
1978	149600	1/30	3	12	34400---1/30---6; 14700---3/18---4; 44400---5/9---2
1979	225700	3/6	6	48	22900---1/10---13; 40700---1/26---8; 116200---3/7---17; 70700---4/14---4; 9900---6/2---3; 13500---11/11---4
1980	312500	3/23	5	32	7900---1/26---4; 28300---3/12---4; 206500---3/23---18; 41500---4/14---4; 9200---5/17---2
1981	73800	12/2	0	0	
1982	212800	1/6	6	43	102800---1/6---7; 44900---1/25---9; 15300---2/8---10; 31900---2/19---7; 53500---12/4---6; 16200---12/18---4
1983	236600	4/7	3	20	132200---4/7---7; 119300---5/22---8; 102500---12/4---5
1984	269800	5/12	1	15	178800---5/12---15
1985	137063	2/5	1	3	24089---2/5---3
1986	159970	11/27	1	4	55005---11/27---4
1987	197725	2/28	2	10	84359---2/28---7; 691---5/26---3
1988	121339	1/23	1	4	18436---1/23---4
1989	249381	10/2	7	56	117679---1/14---8; 68---1/25---1; 39862---2/23---6; 73529---3/7---11; 100098---6/23---14; 14053---7/5---9; 143798---10/2---7
1990	384547	12/25	6	64	26795---1/9---7; 30756---1/25---4; 157038---2/19---31; 16833---3/6---4; 74385---3/17---8; 286219---12/25---15
1991	330926	2/21	4	52	67704---1/1----15; 231363---2/21---20; 41945---4/1---6; 165516---12/5---21
1992	147144	12/27	2	17	27392---1/7---6; 33160---12/27---17
1993	206562	3/26	5	19	23174---1/1---17; 100046---3/26---10; 593---4/3---1; 3308---4/8---1; 74---4/12---1
1994	306432	3/29	3	59	25118---1/30---4; 153680---2/13---29; 193979---3/29---26
1995	162289	3/10	4	23	30870---1/18---4; 40542---2/19---7; 47289---3/10---7; 39912---10/6---5
1996	192535	1/30	6	32	36316---1/9---4; 78863---1/30---10; 39001---2/14---4; 48874---3/8---5; 12127---4/22---3; 62555---12/3---6

Wheeler Spill Compilation

Tennessee Valley Authority
River System Operations

YEAR	MAXIMUM AVERAGE DAILY DISCHARGE (TURBINE + SPILL)	DATE	NUMBER OF PERIODS	TOTAL DAYS	Volumes are average daily in day-second-feet. except as shown. Maximum spill, date of maximum, and number of days of spill in each spill period, in this order. "Total Days" is for calendar year and does not always equal the sum of the days in periods because of extension of periods into adjacent years. All spill is through the spillway. Maximum hourly average discharge to date was 411,900 cfs at 7 p.m. on 3/18/73. *Instantaneous values from monthly report graphs (approximate).
1997	207699	3/6	4	28	34035---1/30---5; 90983---3/4---14; 52416---5/4---3; 63863---6/18---6
1998	240089	4/23	4	26	81250---1/10---7; 35345---2/6---8; 121804---4/23---9; 9992---4/28---2
1999	192313	1/24	3	18	207---1/10---1; 97487---1/24---14; 45188---5/8---3

ANNUAL MAXIMUM AND MINIMUM ELEVATIONS, IN ORDER OF MAGNITUDE

RIVER SCHEDULING

TVA OPERATED RESERVOIR SYSTEM
FROM DATE OF RESERVOIR CLOSURE THROUGH 1999

WHEELER

MAXIMUM					MINIMUM				
)RDER	ELEVATION	YEAR	MONTH	DAY	ORDER	ELEVATION	YEAR	MONTH	DAY
1	557.32	1944	MAR.	1	1	505.50 *	1936	OCT.	3
2	556.87	1937	APR.	30	2	547.21 %	1937	MAR.	21
3	556.56	1963	APR.	29	3	548.43	1962	DEC.	9
4	556.50	1950	JUNE	6	4	548.46	1963	FEB.	9
5	556.49	1949	JUNE	29	5	548.81	1961	JUNE	4
6	556.47	1943	APR.	15	6	549.28	1947	FEB.	5
7	556.47	1946	APR.	14	7	549.35	1952	JAN.	4
8	556.45	1953	MAY	4	8	549.37	1944	JAN.	31
9	556.44	1983	MAY	19	9	549.42	1941	MAR.	4
10	556.43	1941	JULY	12	10	549.47	1949	DEC.	27
11	556.43	1947	APR.	15	11	549.51	1959	JAN.	5
12	556.42	1945	APR.	6	12	549.57	1945	FEB.	28
13	556.42	1958	APR.	26	13	549.57	1965	FEB.	25
14	556.40	1948	DEC.	2	14	549.58	1950	FEB.	23
15	556.40	1951	APR.	20	15	549.60	1954	FEB.	23
16	556.40	1959	APR.	20	16	549.60	1980	FEB.	25
17	556.40	1967	JUNE	24	17	549.67	1964	JAN.	13
18	556.40	1984	MAY	3	18	549.69	1978	FEB.	21
19	556.39	1955	MAY	29	19	549.70	1948	JAN.	1
20	556.39	1956	APR.	18	20	549.72	1939	MAR.	12
21	556.39	1976	JULY	1	21	549.75	1989	DEC.	23
22	556.38	1960	MAY	9	22	549.76	1967	FEB.	3
23	556.36	1954	APR.	19	23	549.77	1951	JAN.	26
24	556.36	1978	MAY	3	24	549.77	1955	JAN.	28
25	556.35	1982	JULY	23	25	549.77	1956	JAN.	10
26	556.35	1997	MAY	2	26	549.77	1977	JAN.	19
27	556.34	1964	APR.	29	27	549.78	1942	OCT.	8
28	556.34	1973	MAY	29	28	549.79	1958	JAN.	1
29	556.34	1980	MAY	17	29	549.79	1985	JAN.	14
30	556.32	1962	JULY	7	30	549.80	1970	FEB.	26
31	556.32	1971	MAY	17	31	549.81	1968	FEB.	7
32	556.32	1975	JUNE	17	32	549.82	1969	JAN.	8
33	556.31	1966	MAY	4	33	549.83	1957	DEC.	27
34	556.31	1969	JUNE	27	34	549.83	1960	DEC.	20
35	556.31	1987	MAY	28	35	549.85	1973	DEC.	10
36	556.31	1999	JULY	12	36	549.90	1975	DEC.	18
37	556.30	1952	JUNE	12	37	549.95	1946	MAR.	12
38	556.30	1968	JULY	19	38	549.95	1953	JAN.	3
39	556.30	1974	MAY	25	39	549.96	1974	MAR.	12
40	556.29	1957	MAY	24	40	549.97	1971	FEB.	13
41	556.29	1996	APR.	22	41	550.00	1972	FEB.	3
42	556.29	1998	JUNE	8	42	550.00	1984	FEB.	5
43	556.28	1965	JUNE	14	43	550.00	1995	FEB.	3
44	556.28	1985	JULY	4	44	550.01	1966	FEB.	12
45	556.28	1989	JUNE	19	45	550.01	1976	MAR.	11
46	556.28	1990	MAY	11	46	550.02	1998	DEC.	22
47	556.28	1993	APR.	30	47	550.02	1999	DEC.	20
48	556.28	1995	MAY	20	48	550.03	1979	FEB.	23
49	556.27	1992	JULY	7	49	550.03	1983	DEC.	24
50	556.26	1961	MAY	29	50	550.03	1993	MAR.	5
51	556.26	1991	APR.	11	51	550.05	1988	FEB.	2
52	556.26	1994	APR.	29	52	550.07	1994	MAR.	19
53	556.25	1970	APR.	21	53	550.10	1992	MAR.	19
54	556.25	1986	JULY	28	54	550.14	1987	DEC.	16
55	556.24	1979	JUNE	6	55	550.16	1981	JAN.	5
56	556.22	1972	APR.	23	56	550.18	1986	MAR.	5
57	556.21	1988	APR.	15	57	550.19	1982	JAN.	31

ANNUAL MAXIMUM AND MINIMUM ELEVATIONS, IN ORDER OF MAGNITUDE

RIVER SCHEDULING

TVA OPERATED RESERVOIR SYSTEM
FROM DATE OF RESERVOIR CLOSURE THROUGH 1999

WHEELER

MAXIMUM					MINIMUM				
)RDER	ELEVATION	YEAR	MONTH	DAY	ORDER	ELEVATION	YEAR	MONTH	DAY
58	556.18	1981	APR.	8	58	550.21 %	1943	FEB.	2
59	556.15	1939	MAY	7	59	550.29	1991	DEC.	21
60	556.15	1977	APR.	24	60	550.38	1938	FEB.	4
61	556.06	1940	APR.	19	61	550.39 %	1940	MAR.	10
62	556.05	1938	APR.	7	62	550.43	1990	MAR.	17
63	555.99	1942	FEB.	23	63	550.66	1996	DEC.	23
64	555.09 %	1936	DEC.	26	64	550.81	1997	DEC.	31

* CLOSURE
% MIDNIGHT ELEVATION
TOP-OF-GATES ELEVATION 556.28

MAXIMUM, MINIMIUM, MEDIAN, AND MEAN

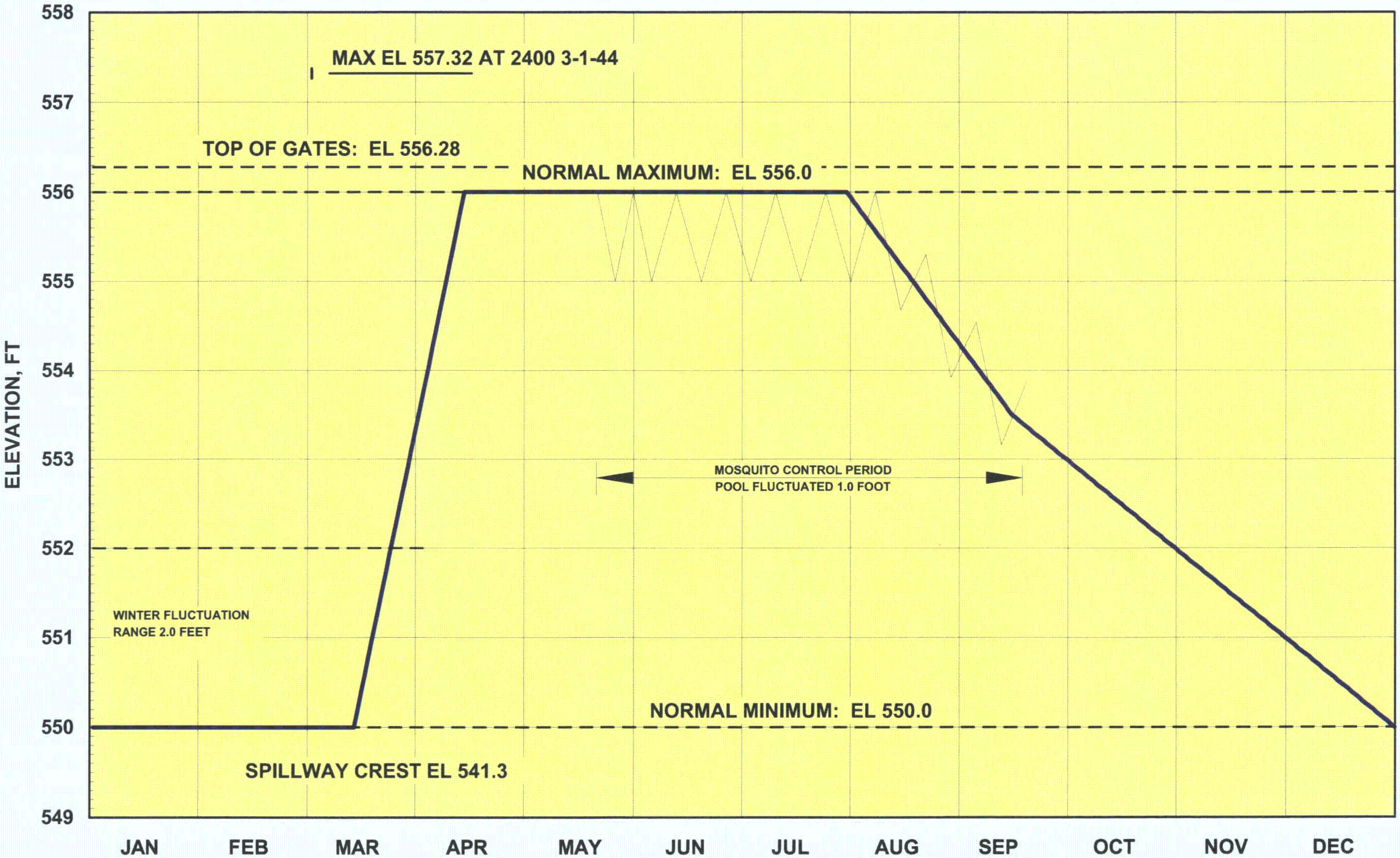
Adjusted Flow by Weeks
Wheeler
Years = 1903-1999

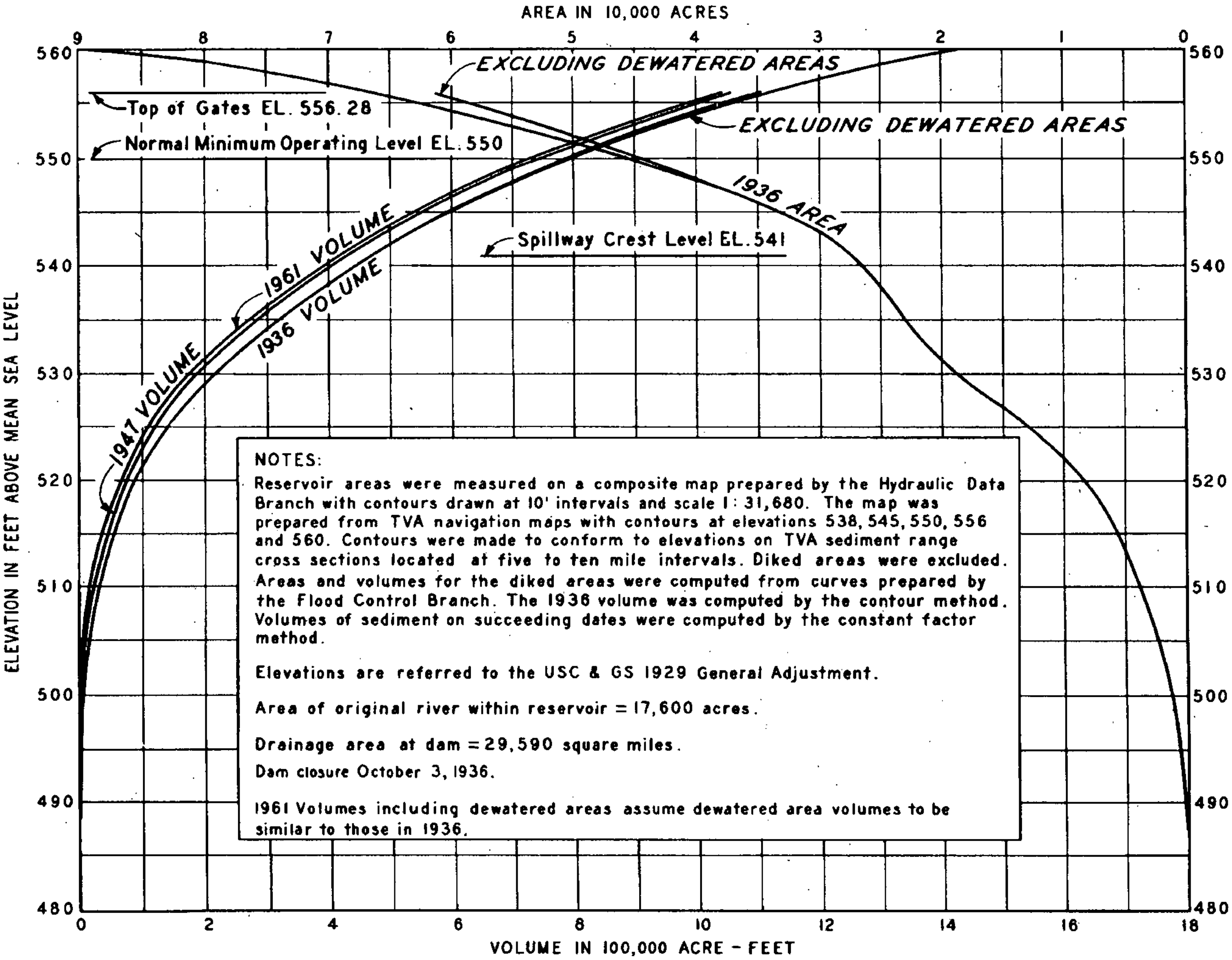
AVERAGE WEEKLY CFS

WEEK ENDING	WEEK NO.	MAXIMUM	YR	MINIMUM	YR	MEDIAN	MEAN
JAN 7	1	310,000	1949	8,500	1940	61,500	81,800
JAN 14	2	341,000	1946	9,310	1981	61,900	78,800
JAN 21	3	397,000	1947	12,200	1981	63,500	74,600
JAN 28	4	278,000	1954	9,120	1940	68,500	86,500
FEB 4	5	531,000	1957	8,810	1940	71,400	87,100
FEB 11	6	255,000	1957	14,800	1934	70,100	88,700
FEB 18	7	410,000	1948	13,500	1934	74,500	94,300
FEB 25	8	348,000	1991	12,600	1934	80,100	95,700
MAR 4	9	275,000	1962	16,200	1941	76,400	90,600
MAR 11	10	280,000	1917	26,500	1986	84,900	98,400
MAR 18	11	482,000	1973	25,300	1981	78,400	105,000
MAR 25	12	376,000	1980	21,600	1988	83,200	93,500
APR 1	13	455,000	1994	22,100	1988	77,600	100,000
APR 8	14	416,000	1977	19,900	1910	75,500	92,000
APR 15	15	251,000	1911	16,900	1986	65,600	79,600
APR 22	16	328,000	1998	16,200	1986	59,800	68,500
APR 29	17	183,000	1970	12,600	1986	56,600	61,400
MAY 6	18	205,000	1984	9,810	1986	46,600	60,400
MAY 13	19	341,000	1984	11,100	1986	45,700	55,400
MAY 20	20	123,000	1983	12,500	1941	39,100	47,300
MAY 27	21	194,000	1983	8,610	1941	36,400	42,700
JUN 3	22	167,000	1973	8,320	1988	30,700	40,300
JUN 10	23	155,000	1909	3,040	1988	29,900	38,700
JUN 17	24	163,000	1989	4,520	1988	27,100	34,400
JUN 24	25	178,000	1989	5,080	1986	25,700	30,700
JUL 1	26	76,800	1928	3,270	1988	22,800	27,600
JUL 8	27	141,000	1989	4,910	1988	23,200	28,900
JUL 15	28	212,000	1916	8,130	1970	22,000	30,400
JUL 22	29	150,000	1916	5,050	1986	20,700	28,900
JUL 29	30	115,000	1916	5,120	1952	21,900	27,300
AUG 5	31	79,600	1971	1,720	1986	21,200	23,900
AUG 12	32	61,800	1942	4,820	1957	20,000	22,400
AUG 19	33	164,000	1920	3,990	1954	19,700	23,700
AUG 26	34	128,000	1920	4,460	1988	17,300	21,600
SEP 2	35	67,300	1950	3,580	1999	15,600	19,800
SEP 9	36	105,000	1928	3,780	1954	15,200	18,500
SEP 16	37	69,400	1950	1,240	1999	14,800	17,400
SEP 23	38	57,300	1920	2,960	1999	12,900	16,400
SEP 30	39	117,000	1989	4,220	1954	13,400	18,500
OCT 7	40	177,000	1989	3,540	1986	12,900	21,200
OCT 14	41	106,000	1906	2,060	1987	12,700	17,400
OCT 21	42	126,000	1975	3,340	1954	12,800	18,000
OCT 28	43	71,400	1977	3,710	1998	14,600	18,900
NOV 4	44	118,000	1949	3,480	1954	14,800	21,000
NOV 11	45	192,000	1977	2,570	1953	15,600	24,000
NOV 18	46	198,000	1957	4,760	1953	16,900	26,400
NOV 25	47	222,000	1957	6,050	1954	23,600	35,000
DEC 2	48	255,000	1948	6,520	1956	23,200	41,400
DEC 9	49	199,000	1991	6,210	1987	34,300	42,700
DEC 16	50	271,000	1972	6,290	1937	37,900	50,900
DEC 23	51	292,000	1961	8,170	1958	34,300	55,600
DEC 31	52	267,000	1926	9,330	1965	55,300	66,100

AVERAGE FLOW: 1903 - 1999 = 49800 CFS

ANNUAL OPERATING CYCLE





ELEV FT	INCLUDING DEWATERED AREAS			EXCLUDING DEWATERED AREAS					
	1936		1961	1936		1947	1953	1956	1961
	AREA AC	VOLUME AC-FT	VOLUME AC-FT	AREA AC	VOLUME AC-FT	VOLUME AC-FT	VOLUME AC-FT	VOLUME AC-FT	VOLUME AC-FT
560	89,100	1,429,000	1,358,000						
556.28	68,000	1,142,000	1,071,000	62,000	1,122,000				
556	67,070	1,121,000	1,050,000	61,190	1,108,000	1,058,000	1,048,000	1,047,000	1,037,000
550	45,450	792,000	720,000	44,810	790,000	740,000	727,000	728,000	718,000
545	33,090	596,000	528,000	33,060	596,000	549,000	538,000	538,000	528,000
541	27,280	472,000		27,260	472,000	432,000	420,000		
538	24,870	393,000	335,000	24,870	393,000	355,000	344,000	343,000	335,000
530	18,600	220,000	171,000	18,600	220,000	190,000	178,000	177,000	171,000
520	8,080	88,600	65,600	8,080	88,500	74,400	67,800	67,300	65,600
510	3,680	31,300	18,100	3,680	31,300	22,200	19,800	19,100	18,100
500	1,220	7,140	800	1,220	7,140	1,810	1,240	1,040	800
490	138	344	0	138	344	0	0	0	0
483.8	0	0	0	0	0	0	0	0	0

THIS DRAWING SUPERSEDES 3-DA-1-321A14R1

TENNESSEE RIVER-MILE 274.9

RESERVOIR AREAS AND VOLUMES

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

SUBMITTED	RECOMMENDED	APPROVED
Edwin K. McCain	Paul C. Spott	[illegible]
KNOXVILLE	12-28-62 3 DA 1	321G784 R1

SAFETY MODIFICATIONS FOR MAXIMUM PROBABLE FLOOD

CHRONOLOGY

Safety analysis studies for Wheeler Dam for the Probable Maximum Flood (PMF) were started on May 10, 1978, and completed on March 4, 1982. Final design started on December 12, 1979, and completed on February 2, 1982. Onsite construction began in January 1982 and was completed in September 1982.

COST OF MODIFICATIONS

Design costs for the dam safety modifications to Wheeler Dam were approximately $30,000. This did not include costs for dam safety evaluation studies which resulted in the modifications. Construction costs were approximately $300,000. The total project cost was approximately $330,000.

CONTROLLING FEATURES

Foundation relief drain holes were drilled on the spillway and non-overflow dam at Wheeler. Then pressure measuring/monitoring devices were installed. This modification lowered the uplift pressure and verified that the dam would be stable during the PMF with the relief holes reducing the hydrologic pressure. These PMF modifications will prevent breach and failure of the dam.

CONSTRUCTION DATA

PERSONNEL

Initial Project

	Total	Dam Construction Only	Units 3 and 4
Peak employed	5,500	4,750	390
Total man-hours	18,392,779	9,927,959	642,519
Injuries	1,321	570	7
Days lost	122,496	74,360	758
Fatalities	7	5	0
Accident frequency	71.8	57.4	10.9
Accident severity	6,660	7,490	1,180

	Units 5-8	Units 9-11	New locks
Peak employed	360	-	-
Total man-hours	1,025,342	2,675,904	3,111,914
Injuries	12	23	31
Days lost	380	6,411	19,599
Fatalities	0	0	2
Accident frequency	11.7	8.60	9.96
Accident severity	371	2,396	6,298

CONSTRUCTION DATA (CONT.)

QUANTITIES

Initial Project

Dam and power facilities:
- Excavation .... 548,000 cu. yd
- Concrete .... 631,000 cu. yd
- Reinforcing steel .... 8,500 tons
- Form work .... 3,000,000 sq. ft

Initial lock, by Corps of Engineers:
- Concrete .... 121,000 cu. yd

Highway and railroad:
- Excavation .... 1,230,000 cu. yd

Units 3 and 4:
- Concrete .... 18,600 cu. yd
- Reinforcing steel .... 847 tons
- Form work .... 122,600 sq. ft

Units 5-8
- Concrete .... 37,800 cu. yd
- Reinforcing steel .... 1,673 tons
- Form work .... 244,000 sq. ft

Units 9-11:
- Excavation .... Rock, 66,100 cu. yd; concrete, 21,400 cu. yd; unclassified, 1,000 cu. yd
- Concrete placed .... 64,000 cu. yd
- Reinforcing steel .... 2,900 tons
- Form work .... 444,000 sq. ft

Main Lock:
- Dredging .... Rock, 6,100 cu. yd; other, 95,000 cu. yd
- Excavation .... Rock, 68,000 cu. yd; other, 75,000 cu. yd; earthwork or grading, 50,000 cu. yd
- Fills and dikes .... 240,000 cu. yd
- Concrete placed .... 227,000 cu. yd
- Reinforcing steel .... 1,450 tons
- Form work .... 750,000 sq. ft

CONSTRUCTION DATA (CONT.)

QUANTITIES (CONT.)

Auxiliary lock:
(1962 Construction Only)

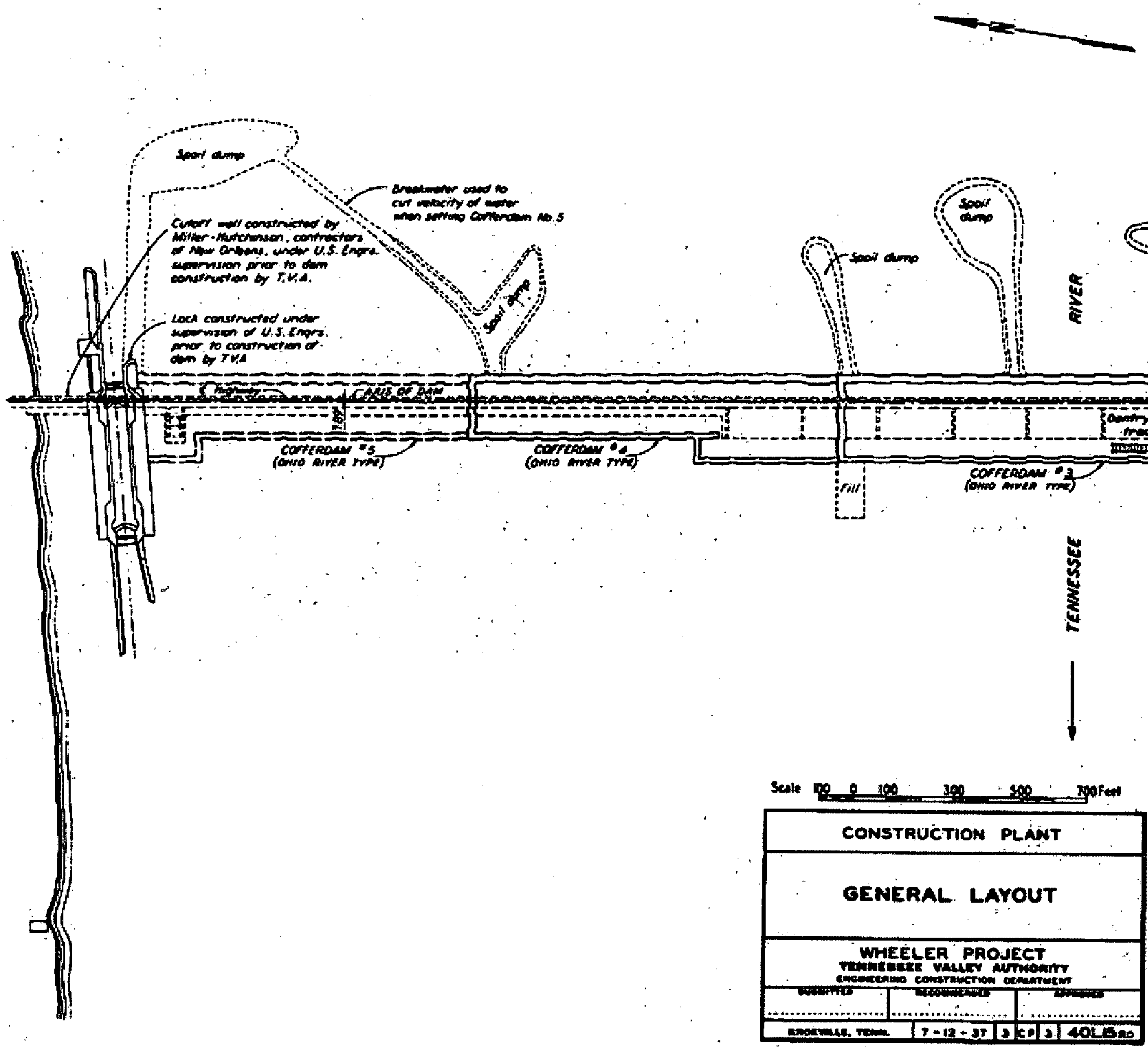
Excavation	Rock, 13,600 cu. yd; concrete, 66,000 cu. yd;
Concrete placed	89,000 cu. yd
Reinforcing steel	430 tons
Form work	273,000 sq. ft

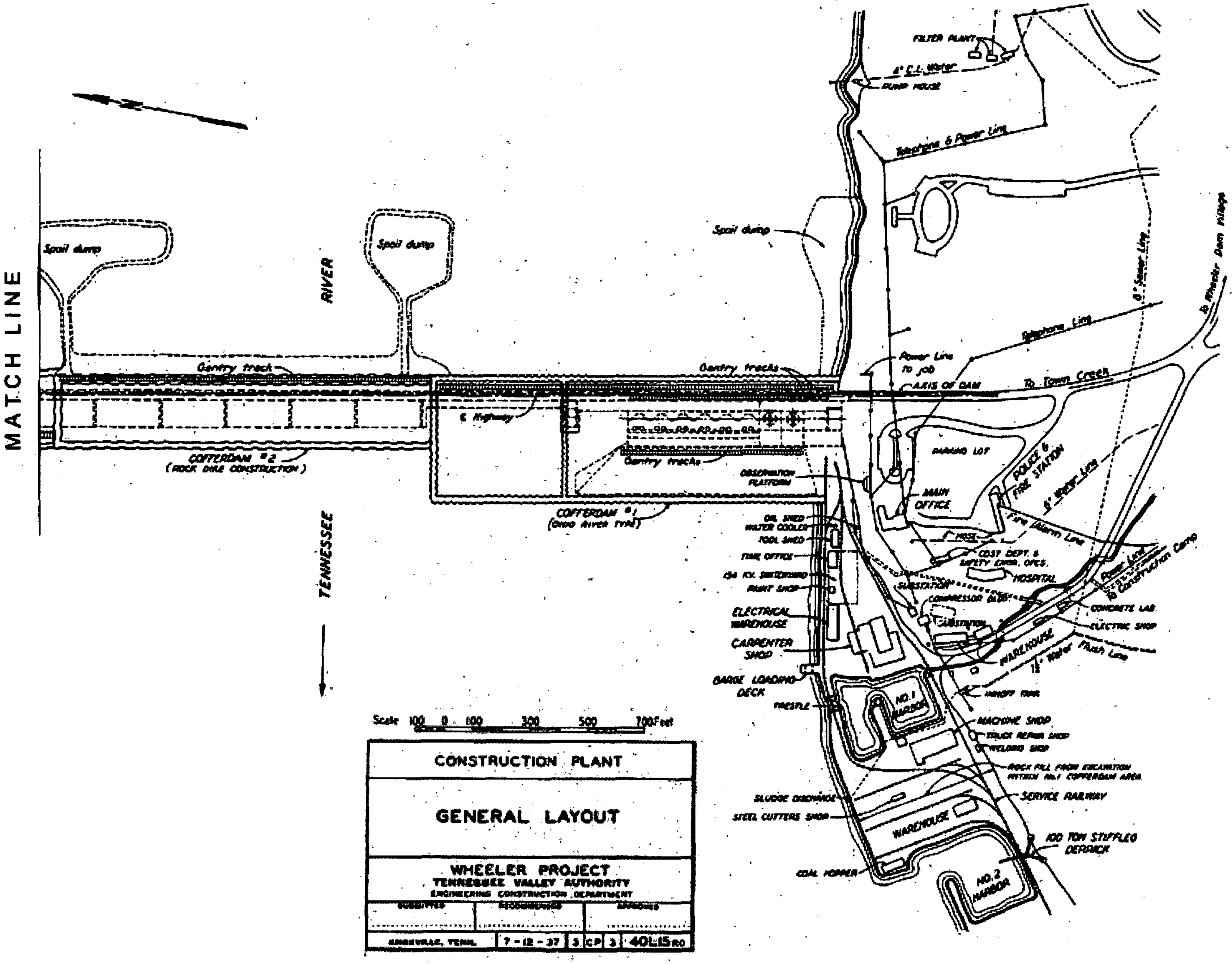
HOUSING FACILITIES

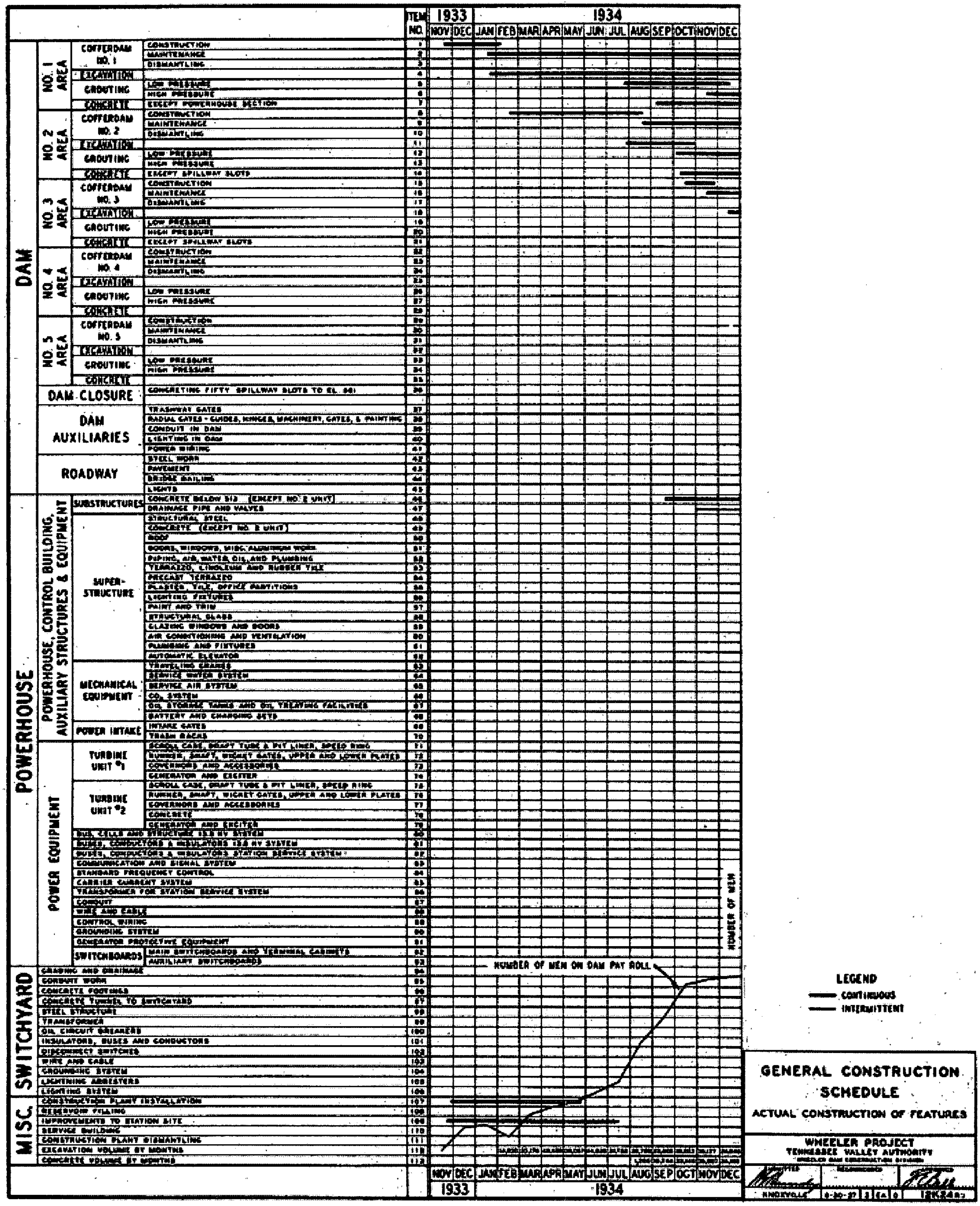
Initial Project

Permanent houses built	15
Semi-permanent houses built	None
Low-cost houses built	44
Dormitories built:	
Staff (120 capacity)	1
Men (600 total capacity)	5

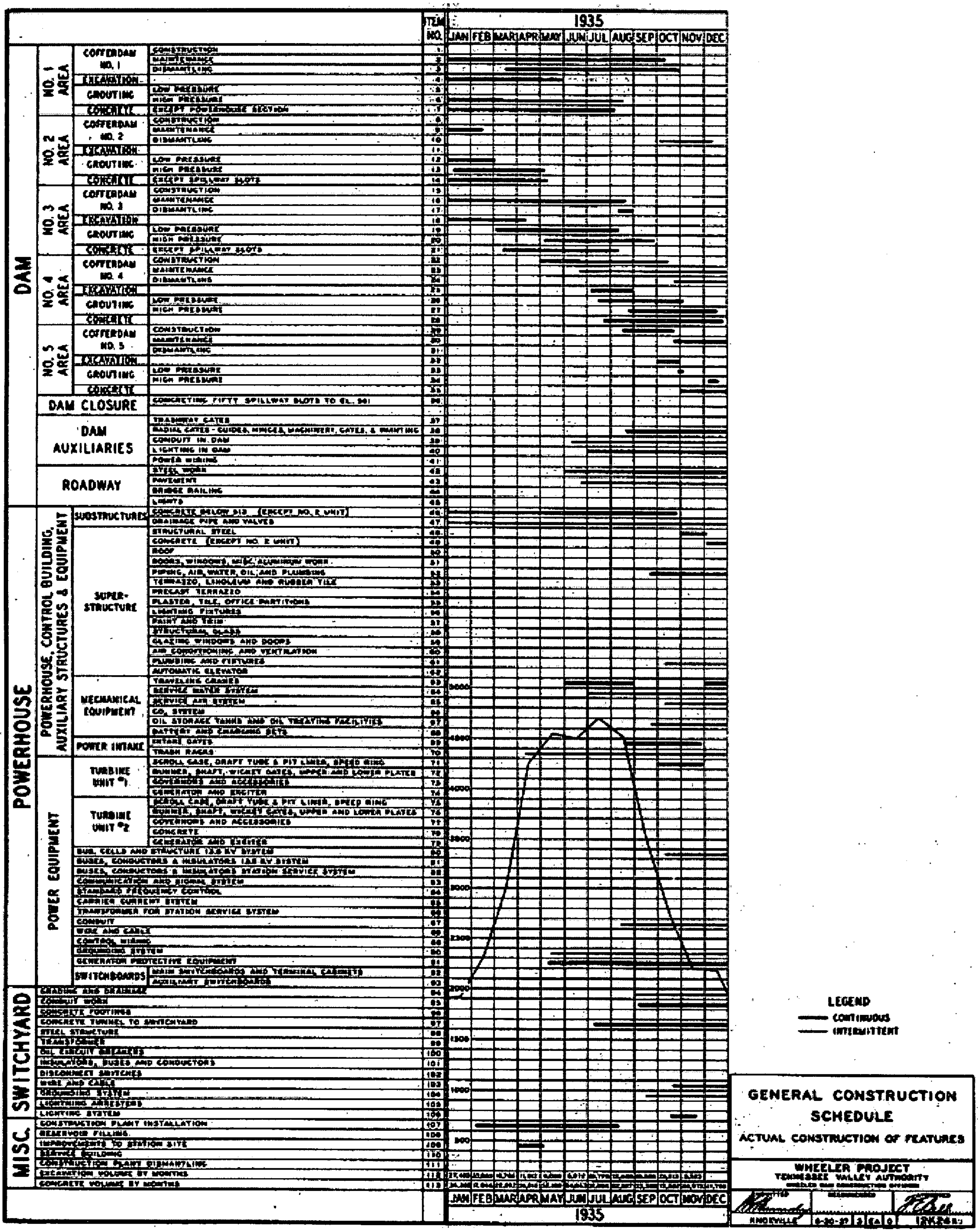
Public buildings constructed included a cafeteria (516 seats), a hospital (14 beds), 2 community and recreation buildings, and stores.

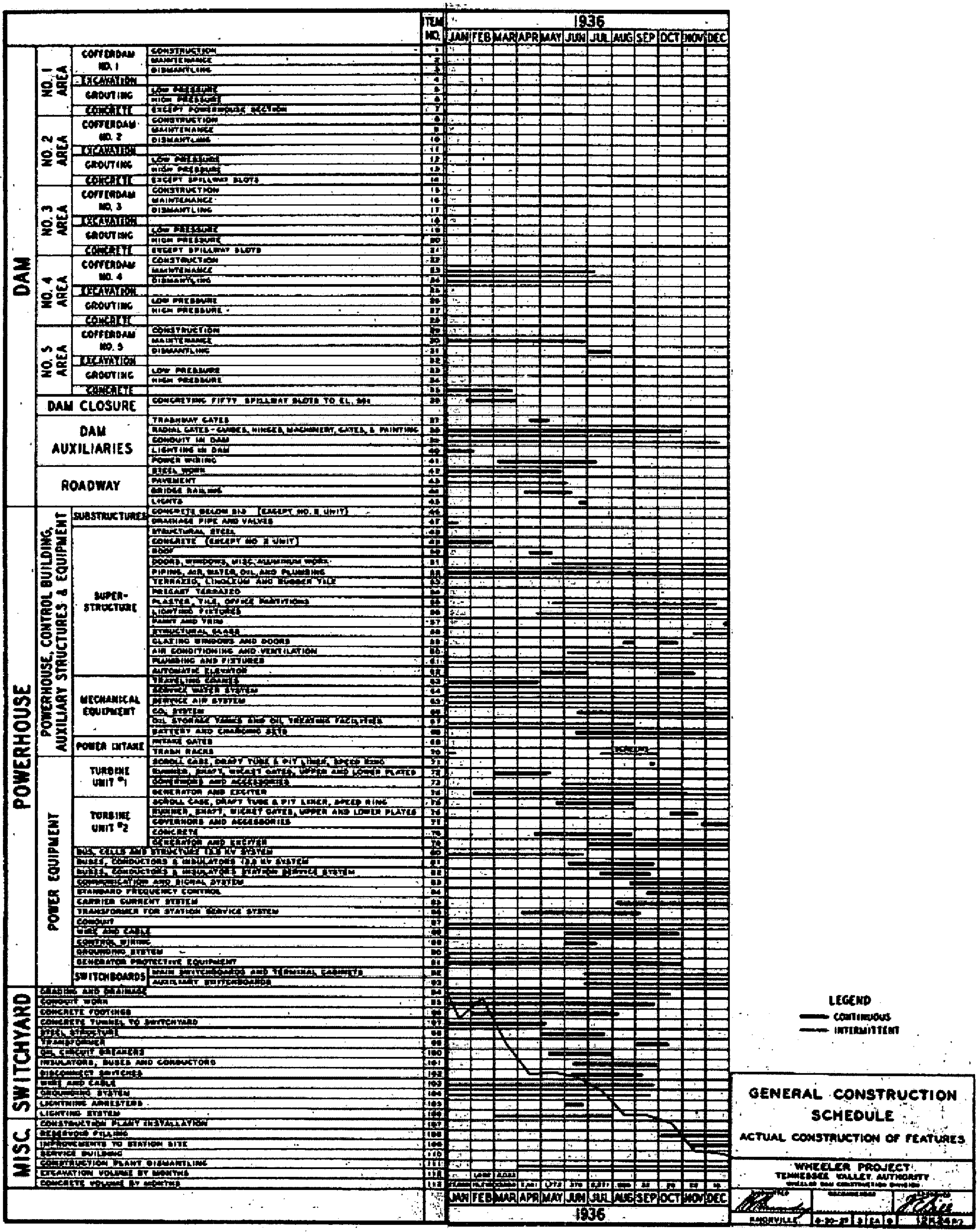

Spoil dump
Breakwater used to cut velocity of water when setting Cofferdam No. 5
Cutoff wall constructed by Miller-Hutchinson, contractors of New Orleans, under U.S. Engrs. supervision prior to dam construction by T.V.A.
Lock constructed under supervision of U.S. Engrs. prior to construction of dam by T.V.A.
Spoil dump
Spoil dump
Spoil dump
Spoil dump
Highway
AXIS OF DAM
COFFERDAM #5 (OHIO RIVER TYPE)
COFFERDAM #4 (OHIO RIVER TYPE)
COFFERDAM #3 (OHIO RIVER TYPE)
Fill
Gantry track
RIVER
TENNESSEE
MATCH LINE
Scale 100 0 100 300 500 700 Feet
CONSTRUCTION PLANT
GENERAL LAYOUT
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
ENGINEERING CONSTRUCTION DEPARTMENT
7-12-37
40L15


MATCH LINE
Spoil dump
Spoil dump
Spoil dump
RIVER
TENNESSEE
Gantry track
Gantry tracks
Gantry tracks
℄ Highway
COFFERDAM #2
(ROCK DIKE CONSTRUCTION)
COFFERDAM #1
(OHIO RIVER TYPE)
FILTER PLANT
4" C.I. Water
DUMP HOUSE
Telephone & Power Line
Telephone Line
Power Line to job
AXIS OF DAM
To Town Creek
8" Sewer Line
To Wheeler Dam Village
PARKING LOT
MAIN OFFICE
POLICE & FIRE STATION
6" Water Line
Fire Alarm Line
OBSERVATION PLATFORM
OIL SHED
WATER COOLER
TOOL SHED
TIME OFFICE
PAINT SHOP
ELECTRICAL WAREHOUSE
CARPENTER SHOP
BARGE LOADING DECK
TRESTLE
HOSPITAL
SUBSTATION
COMPRESSOR BLDG.
SUBSTATION
WAREHOUSE
CONCRETE LAB.
ELECTRIC SHOP
Power Line
To Construction Camp
Flush Line
NO. 1 HARBOR
MACHINE SHOP
TRUCK REPAIR SHOP
WELDING SHOP
SERVICE RAILWAY
SLUDGE DISCHARGE
STEEL CUTTERS SHOP
WAREHOUSE
COAL HOPPER
NO. 2 HARBOR
100 TON STIFFLEG DERRICK
Scale 100 0 100 300 500 700 Feet
CONSTRUCTION PLANT
GENERAL LAYOUT
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
ENGINEERING CONSTRUCTION DEPARTMENT
7-12-37
40L15



GENERAL CONSTRUCTION SCHEDULE
ACTUAL CONSTRUCTION OF FEATURES
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
KNOXVILLE
ITEM NO.
1933 NOV DEC
1934 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
DAM
NO. 1 AREA
COFFERDAM NO. 1
CONSTRUCTION
MAINTENANCE
DISMANTLING
EXCAVATION
GROUTING
LOW PRESSURE
HIGH PRESSURE
CONCRETE
EXCEPT POWERHOUSE SECTION
NO. 2 AREA
COFFERDAM NO. 2
EXCEPT SPILLWAY SLOTS
NO. 3 AREA
COFFERDAM NO. 3
NO. 4 AREA
COFFERDAM NO. 4
NO. 5 AREA
COFFERDAM NO. 5
DAM CLOSURE
CONCRETING FIFTY SPILLWAY SLOTS TO EL. 561
DAM AUXILIARIES
TRASHWAY GATES
RADIAL GATES - GUIDES, HINGES, MACHINERY, GATES, & PAINTING
CONDUIT IN DAM
LIGHTING IN DAM
POWER WIRING
ROADWAY
STEEL WORK
PAVEMENT
BRIDGE RAILING
LIGHTS
POWERHOUSE
POWERHOUSE, CONTROL BUILDING, AUXILIARY STRUCTURES & EQUIPMENT
SUBSTRUCTURES
CONCRETE BELOW 512 (EXCEPT NO. 2 UNIT)
DRAINAGE PIPE AND VALVES
SUPER-STRUCTURE
STRUCTURAL STEEL
CONCRETE (EXCEPT NO. 2 UNIT)
ROOF
DOORS, WINDOWS, MISC. ALUMINUM WORK
PIPING, AIR, WATER, OIL, AND PLUMBING
TERRAZZO, LINOLEUM AND RUBBER TILE
PRECAST TERRAZZO
PLASTER, TILE, OFFICE PARTITIONS
LIGHTING FIXTURES
PAINT AND TRIM
STRUCTURAL GLASS
GLAZING WINDOWS AND DOORS
AIR CONDITIONING AND VENTILATION
PLUMBING AND FIXTURES
AUTOMATIC ELEVATOR
MECHANICAL EQUIPMENT
TRAVELING CRANES
SERVICE WATER SYSTEM
SERVICE AIR SYSTEM
CO2 SYSTEM
OIL STORAGE TANKS AND OIL TREATING FACILITIES
BATTERY AND CHARGING SETS
POWER INTAKE
INTAKE GATES
TRASH RACKS
POWER EQUIPMENT
TURBINE UNIT #1
SCROLL CASE, DRAFT TUBE & PIT LINER, SPEED RING
RUNNER, SHAFT, WICKET GATES, UPPER AND LOWER PLATES
GOVERNORS AND ACCESSORIES
GENERATOR AND EXCITER
TURBINE UNIT #2
CONCRETE
BUS, CELLS AND STRUCTURE 13.8 KV SYSTEM
BUSES, CONDUCTORS & INSULATORS 13.8 KV SYSTEM
BUSES, CONDUCTORS & INSULATORS STATION SERVICE SYSTEM
COMMUNICATION AND SIGNAL SYSTEM
STANDARD FREQUENCY CONTROL
CARRIER CURRENT SYSTEM
TRANSFORMER FOR STATION SERVICE SYSTEM
CONDUIT
WIRE AND CABLE
CONTROL WIRING
GROUNDING SYSTEM
GENERATOR PROTECTIVE EQUIPMENT
SWITCHBOARDS
MAIN SWITCHBOARDS AND TERMINAL CABINETS
AUXILIARY SWITCHBOARDS
SWITCHYARD
GRADING AND DRAINAGE
CONDUIT WORK
CONCRETE FOOTINGS
CONCRETE TUNNEL TO SWITCHYARD
STEEL STRUCTURE
TRANSFORMER
OIL CIRCUIT BREAKERS
INSULATORS, BUSES AND CONDUCTORS
DISCONNECT SWITCHES
WIRE AND CABLE
GROUNDING SYSTEM
LIGHTNING ARRESTERS
LIGHTING SYSTEM
MISC.
CONSTRUCTION PLANT INSTALLATION
RESERVOIR FILLING
IMPROVEMENTS TO STATION SITE
SERVICE BUILDING
CONSTRUCTION PLANT DISMANTLING
EXCAVATION VOLUME BY MONTHS
CONCRETE VOLUME BY MONTHS
NUMBER OF MEN ON DAM PAY ROLL
NUMBER OF MEN
LEGEND
CONTINUOUS
INTERMITTENT


1935
ITEM NO.
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
DAM
NO. 1 AREA
COFFERDAM NO. 1
CONSTRUCTION
MAINTENANCE
DISMANTLING
EXCAVATION
GROUTING
LOW PRESSURE
HIGH PRESSURE
CONCRETE
EXCEPT POWERHOUSE SECTION
NO. 2 AREA
COFFERDAM NO. 2
CONSTRUCTION
MAINTENANCE
DISMANTLING
EXCAVATION
GROUTING
LOW PRESSURE
HIGH PRESSURE
CONCRETE
EXCEPT SPILLWAY SLOTS
NO. 3 AREA
COFFERDAM NO. 3
CONSTRUCTION
MAINTENANCE
DISMANTLING
EXCAVATION
GROUTING
LOW PRESSURE
HIGH PRESSURE
CONCRETE
EXCEPT SPILLWAY SLOTS
NO. 4 AREA
COFFERDAM NO. 4
CONSTRUCTION
MAINTENANCE
DISMANTLING
EXCAVATION
GROUTING
LOW PRESSURE
HIGH PRESSURE
CONCRETE
NO. 5 AREA
COFFERDAM NO. 5
CONSTRUCTION
MAINTENANCE
DISMANTLING
EXCAVATION
GROUTING
LOW PRESSURE
HIGH PRESSURE
CONCRETE
DAM CLOSURE
CONCRETING FIFTY SPILLWAY SLOTS TO EL. 561
DAM AUXILIARIES
TRASHWAY GATES
RADIAL GATES - GUIDES, HINGES, MACHINERY, GATES, & PAINTING
CONDUIT IN DAM
LIGHTING IN DAM
POWER WIRING
ROADWAY
STEEL WORK
PAVEMENT
BRIDGE RAILING
LIGHTS
POWERHOUSE
POWERHOUSE, CONTROL BUILDING, AUXILIARY STRUCTURES & EQUIPMENT
SUBSTRUCTURES
CONCRETE BELOW 513 (EXCEPT NO. 2 UNIT)
DRAINAGE PIPE AND VALVES
SUPER-STRUCTURE
STRUCTURAL STEEL
CONCRETE (EXCEPT NO. 2 UNIT)
ROOF
DOORS, WINDOWS, MISC. ALUMINUM WORK
PIPING, AIR, WATER, OIL, AND PLUMBING
TERRAZZO, LINOLEUM AND RUBBER TILE
PRECAST TERRAZZO
PLASTER, TILE, OFFICE PARTITIONS
LIGHTING FIXTURES
PAINT AND TRIM
STRUCTURAL GLASS
GLAZING WINDOWS AND DOORS
AIR CONDITIONING AND VENTILATION
PLUMBING AND FIXTURES
AUTOMATIC ELEVATOR
MECHANICAL EQUIPMENT
TRAVELING CRANES
SERVICE WATER SYSTEM
SERVICE AIR SYSTEM
CO2 SYSTEM
OIL STORAGE TANKS AND OIL TREATING FACILITIES
BATTERY AND CHARGING SETS
POWER INTAKE
INTAKE GATES
TRASH RACKS
POWER EQUIPMENT
TURBINE UNIT #1
SCROLL CASE, DRAFT TUBE & PIT LINER, SPEED RING
RUNNER, SHAFT, WICKET GATES, UPPER AND LOWER PLATES
GOVERNORS AND ACCESSORIES
GENERATOR AND EXCITER
TURBINE UNIT #2
SCROLL CASE, DRAFT TUBE & PIT LINER, SPEED RING
RUNNER, SHAFT, WICKET GATES, UPPER AND LOWER PLATES
GOVERNORS AND ACCESSORIES
CONCRETE
GENERATOR AND EXCITER
BUS, CELLS AND STRUCTURE 13.8 KV SYSTEM
BUSES, CONDUCTORS & INSULATORS 13.8 KV SYSTEM
BUSES, CONDUCTORS & INSULATORS STATION SERVICE SYSTEM
COMMUNICATION AND SIGNAL SYSTEM
STANDARD FREQUENCY CONTROL
CARRIER CURRENT SYSTEM
TRANSFORMER FOR STATION SERVICE SYSTEM
CONDUIT
WIRE AND CABLE
CONTROL WIRING
GROUNDING SYSTEM
GENERATOR PROTECTIVE EQUIPMENT
SWITCHBOARDS
MAIN SWITCHBOARDS AND TERMINAL CABINETS
AUXILIARY SWITCHBOARDS
SWITCHYARD
GRADING AND DRAINAGE
CONDUIT WORK
CONCRETE FOOTINGS
CONCRETE TUNNEL TO SWITCHYARD
STEEL STRUCTURE
TRANSFORMER
OIL CIRCUIT BREAKERS
INSULATORS, BUSES AND CONDUCTORS
DISCONNECT SWITCHES
WIRE AND CABLE
GROUNDING SYSTEM
LIGHTNING ARRESTERS
LIGHTING SYSTEM
MISC.
CONSTRUCTION PLANT INSTALLATION
RESERVOIR FILLING
IMPROVEMENTS TO STATION SITE
SERVICE BUILDING
CONSTRUCTION PLANT DISMANTLING
EXCAVATION VOLUME BY MONTHS
CONCRETE VOLUME BY MONTHS
LEGEND
CONTINUOUS
INTERMITTENT
GENERAL CONSTRUCTION SCHEDULE
ACTUAL CONSTRUCTION OF FEATURES
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
KNOXVILLE


1936
ITEM NO.
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
DAM
NO. 1 AREA
COFFERDAM NO. 1
CONSTRUCTION
MAINTENANCE
DISMANTLING
EXCAVATION
GROUTING
LOW PRESSURE
HIGH PRESSURE
CONCRETE
EXCEPT POWERHOUSE SECTION
NO. 2 AREA
COFFERDAM NO. 2
EXCEPT SPILLWAY SLOTS
NO. 3 AREA
COFFERDAM NO. 3
NO. 4 AREA
COFFERDAM NO. 4
NO. 5 AREA
COFFERDAM NO. 5
DAM CLOSURE
DAM AUXILIARIES
TRASHWAY GATES
CONDUIT IN DAM
LIGHTING IN DAM
POWER WIRING
ROADWAY
STEEL WORK
PAVEMENT
BRIDGE RAILING
LIGHTS
POWERHOUSE
POWERHOUSE, CONTROL BUILDING, AUXILIARY STRUCTURES & EQUIPMENT
SUBSTRUCTURES
DRAINAGE PIPE AND VALVES
SUPER-STRUCTURE
STRUCTURAL STEEL
ROOF
PRECAST TERRAZZO
LIGHTING FIXTURES
PAINT AND TRIM
STRUCTURAL GLASS
GLAZING WINDOWS AND DOORS
AIR CONDITIONING AND VENTILATION
PLUMBING AND FIXTURES
AUTOMATIC ELEVATOR
MECHANICAL EQUIPMENT
TRAVELING CRANES
SERVICE WATER SYSTEM
SERVICE AIR SYSTEM
BATTERY AND CHARGING SETS
POWER INTAKE
INTAKE GATES
TRASH RACKS
POWER EQUIPMENT
TURBINE UNIT #1
GOVERNORS AND ACCESSORIES
GENERATOR AND EXCITER
TURBINE UNIT #2
CONCRETE
STANDARD FREQUENCY CONTROL
CARRIER CURRENT SYSTEM
TRANSFORMER FOR STATION SERVICE SYSTEM
CONDUIT
WIRE AND CABLE
CONTROL WIRING
GROUNDING SYSTEM
GENERATOR PROTECTIVE EQUIPMENT
SWITCHBOARDS
AUXILIARY SWITCHBOARDS
SWITCHYARD
GRADING AND DRAINAGE
CONDUIT WORK
CONCRETE FOOTINGS
CONCRETE TUNNEL TO SWITCHYARD
STEEL STRUCTURE
TRANSFORMER
OIL CIRCUIT BREAKERS
INSULATORS, BUSES AND CONDUCTORS
DISCONNECT SWITCHES
WIRE AND CABLE
GROUNDING SYSTEM
LIGHTNING ARRESTERS
LIGHTING SYSTEM
MISC.
CONSTRUCTION PLANT INSTALLATION
RESERVOIR FILLING
IMPROVEMENTS TO STATION SITE
SERVICE BUILDING
CONSTRUCTION PLANT DISMANTLING
EXCAVATION VOLUME BY MONTHS
CONCRETE VOLUME BY MONTHS
LEGEND
CONTINUOUS
INTERMITTENT
GENERAL CONSTRUCTION SCHEDULE
ACTUAL CONSTRUCTION OF FEATURES
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
KNOXVILLE

				ITEM NO.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
					1937							
DAM	NO. 1 AREA	COFFERDAM NO. 1	CONSTRUCTION	1								
			MAINTENANCE	2								
			DISMANTLING	3								
		EXCAVATION		4								
		GROUTING	LOW PRESSURE	5								
			HIGH PRESSURE	6								
		CONCRETE	EXCEPT POWERHOUSE SECTION	7								
	NO. 2 AREA	COFFERDAM NO. 2	CONSTRUCTION	8								
			MAINTENANCE	9								
			DISMANTLING	10								
		EXCAVATION		11								
		GROUTING	LOW PRESSURE	12								
			HIGH PRESSURE	13								
		CONCRETE	EXCEPT SPILLWAY SLOTS	14								
	NO. 3 AREA	COFFERDAM NO. 3	CONSTRUCTION	15								
			MAINTENANCE	16								
			DISMANTLING	17								
		EXCAVATION		18								
		GROUTING	LOW PRESSURE	19								
			HIGH PRESSURE	20								
		CONCRETE	EXCEPT SPILLWAY SLOTS	21								
	NO. 4 AREA	COFFERDAM NO. 4	CONSTRUCTION	22								
			MAINTENANCE	23								
			DISMANTLING	24								
		EXCAVATION		25								
		GROUTING	LOW PRESSURE	26								
			HIGH PRESSURE	27								
		CONCRETE		28								
	NO. 5 AREA	COFFERDAM NO. 5	CONSTRUCTION	29								
			MAINTENANCE	30								
			DISMANTLING	31								
		EXCAVATION		32								
		GROUTING	LOW PRESSURE	33								
			HIGH PRESSURE	34								
		CONCRETE		35								
	DAM CLOSURE		CONCRETING FIFTY SPILLWAY SLOTS TO EL. 561	36								
	DAM AUXILIARIES		TRASHWAY GATES	37								
			RADIAL GATES - GUIDES, HINGES, MACHINERY, GATES, & PAINTING	38								
			CONDUIT IN DAM	39								
			LIGHTING IN DAM	40								
			POWER WIRING	41								
	ROADWAY		STEEL WORK	42								
			PAVEMENT	43								
			BRIDGE RAILING	44								
			LIGHTS	45								
POWERHOUSE	POWERHOUSE, CONTROL BUILDING, AUXILIARY STRUCTURES & EQUIPMENT	SUBSTRUCTURES	CONCRETE BELOW 513 (EXCEPT NO. 2 UNIT)	46								
			DRAINAGE PIPE AND VALVES	47								
		SUPER-STRUCTURE	STRUCTURAL STEEL	48								
			CONCRETE (EXCEPT NO. 2 UNIT)	49								
			ROOF	50								
			DOORS, WINDOWS, MISC. ALUMINUM WORK	51								
			PIPING, AIR, WATER, OIL, AND PLUMBING	52								
			TERRAZZO, LINOLEUM AND RUBBER TILE	53								
			PRECAST TERRAZZO	54								
			PLASTER, TILE, OFFICE PARTITIONS	55								
			LIGHTING FIXTURES	56								
			PAINT AND TRIM	57								
			STRUCTURAL GLASS	58								
			GLAZING WINDOWS AND DOORS	59								
			AIR CONDITIONING AND VENTILATION	60								
			PLUMBING AND FIXTURES	61								
			AUTOMATIC ELEVATOR	62								
		MECHANICAL EQUIPMENT	TRAVELING CRANES	63								
			SERVICE WATER SYSTEM	64								
			SERVICE AIR SYSTEM	65								
			CO_2 SYSTEM	66								
			OIL STORAGE TANKS AND OIL TREATING FACILITIES	67								
			BATTERY AND CHARGING SETS	68								
		POWER INTAKE	INTAKE GATES	69								
			TRASH RACKS	70								
	POWER EQUIPMENT	TURBINE UNIT #1	SCROLL CASE, DRAFT TUBE & PIT LINER, SPEED RING	71								
			RUNNER, SHAFT, WICKET GATES, UPPER AND LOWER PLATES	72								
			GOVERNORS AND ACCESSORIES	73								
			GENERATOR AND EXCITER	74								
		TURBINE UNIT #2	SCROLL CASE, DRAFT TUBE & PIT LINER, SPEED RING	75								
			RUNNER, SHAFT, WICKET GATES, UPPER AND LOWER PLATES	76								
			GOVERNORS AND ACCESSORIES	77								
			CONCRETE	78								
			GENERATOR AND EXCITER	79								
		BUS, CELLS AND STRUCTURE 13.8 KV SYSTEM		80								
		BUSES, CONDUCTORS & INSULATORS 132 KV SYSTEM		81								
		BUSES, CONDUCTORS & INSULATORS STATION SERVICE SYSTEM		82								
		COMMUNICATION AND SIGNAL SYSTEM		83								
		STANDARD FREQUENCY CONTROL		84								
		CARRIER CURRENT SYSTEM		85								
		TRANSFORMER FOR STATION SERVICE SYSTEM		86								
		CONDUIT		87								
		WIRE AND CABLE		88								
		CONTROL WIRING		89								
		GROUNDING SYSTEM		90								
		GENERATOR PROTECTIVE EQUIPMENT		91								
		SWITCHBOARDS	MAIN SWITCHBOARDS AND TERMINAL CABINETS	92								
			AUXILIARY SWITCHBOARDS	93								
SWITCHYARD	GRADING AND DRAINAGE			94								
	CONDUIT WORK			95								
	CONCRETE FOOTINGS			96								
	CONCRETE TUNNEL TO SWITCHYARD			97								
	STEEL STRUCTURE			98								
	TRANSFORMER			99								
	OIL CIRCUIT BREAKERS			100								
	INSULATORS, BUSES AND CONDUCTORS			101								
	DISCONNECT SWITCHES			102								
	WIRE AND CABLE			103								
	GROUNDING SYSTEM			104								
	LIGHTNING ARRESTERS			105								
	LIGHTING SYSTEM			106								
MISC.	CONSTRUCTION PLANT INSTALLATION			107								
	RESERVOIR FILLING			108								
	IMPROVEMENTS TO STATION SITE			109								
	SERVICE BUILDING			110								
	CONSTRUCTION PLANT DISMANTLING			111								
	EXCAVATION VOLUME BY MONTHS			112								
	CONCRETE VOLUME BY MONTHS			113	[illegible]	[illegible]	[illegible]					
					JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
					1937							

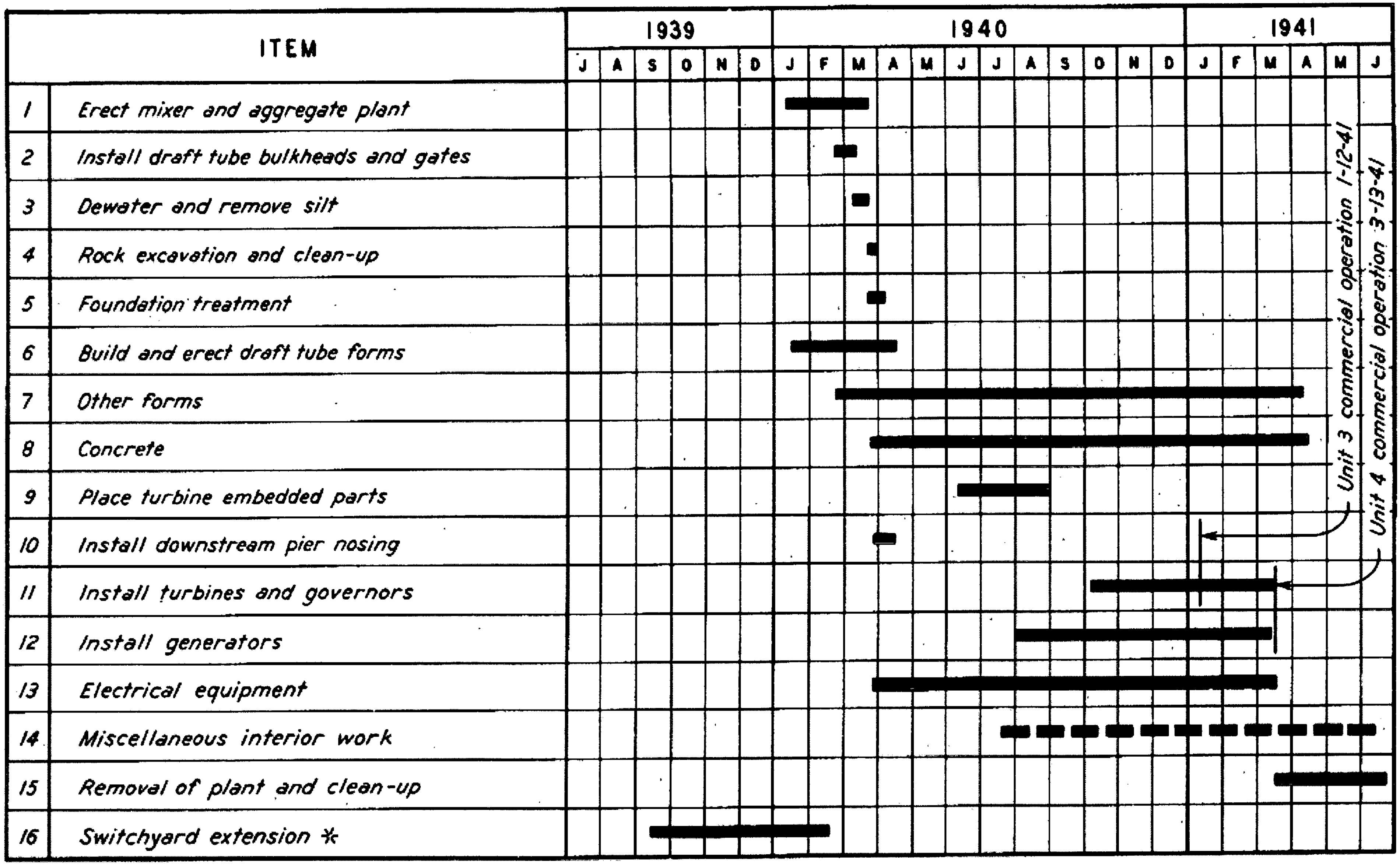
LEGEND
- CONTINUOUS
- INTERMITTENT

GENERAL CONSTRUCTION SCHEDULE

ACTUAL CONSTRUCTION OF FEATURES

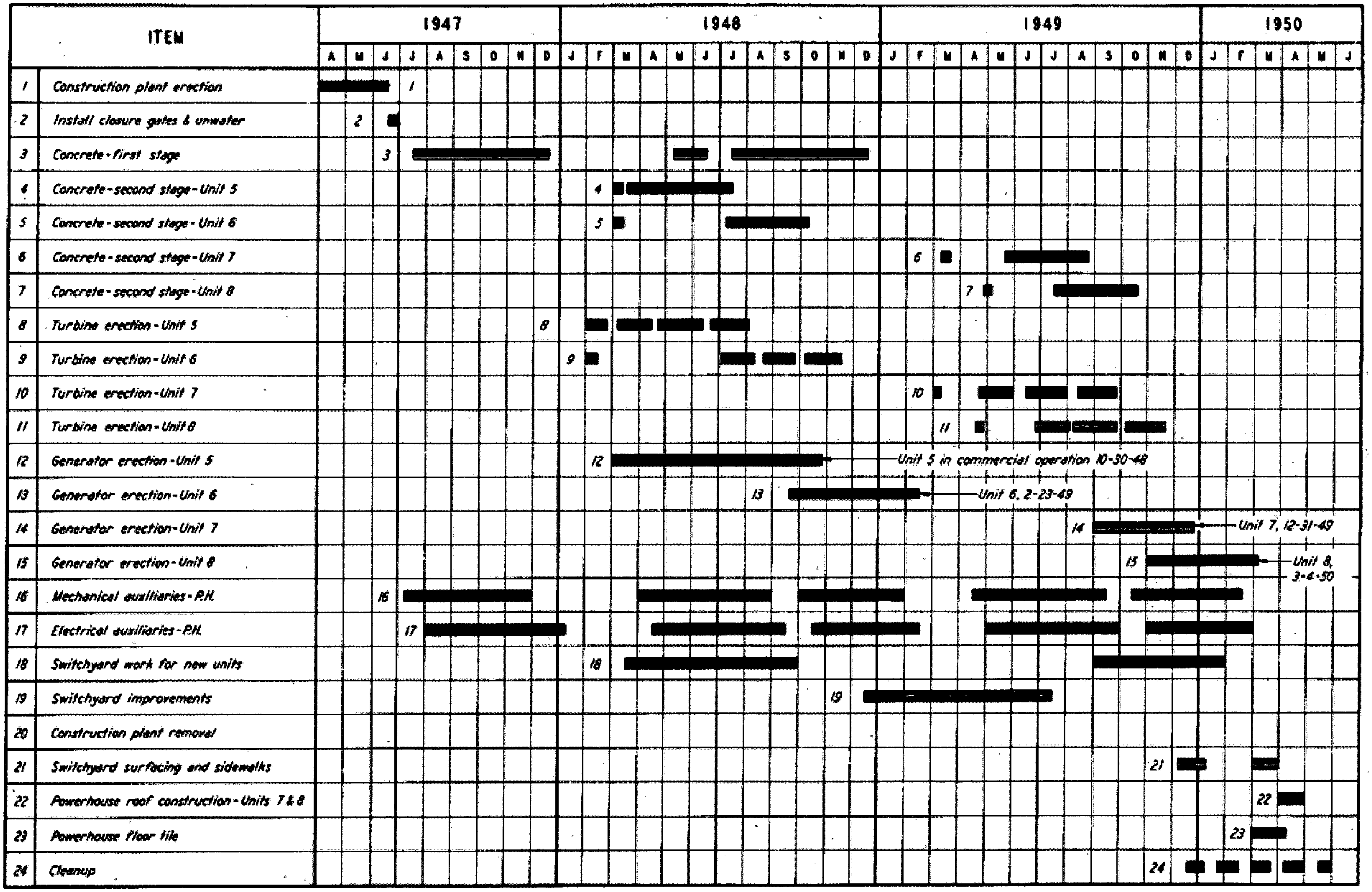
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY
WHEELER DAM CONSTRUCTION DIVISION

SUBMITTED	RECOMMENDED	APPROVED
[signature]		[signature]
KNOXVILLE	9-30-37 [illegible] EA 0	12 R 24 R2



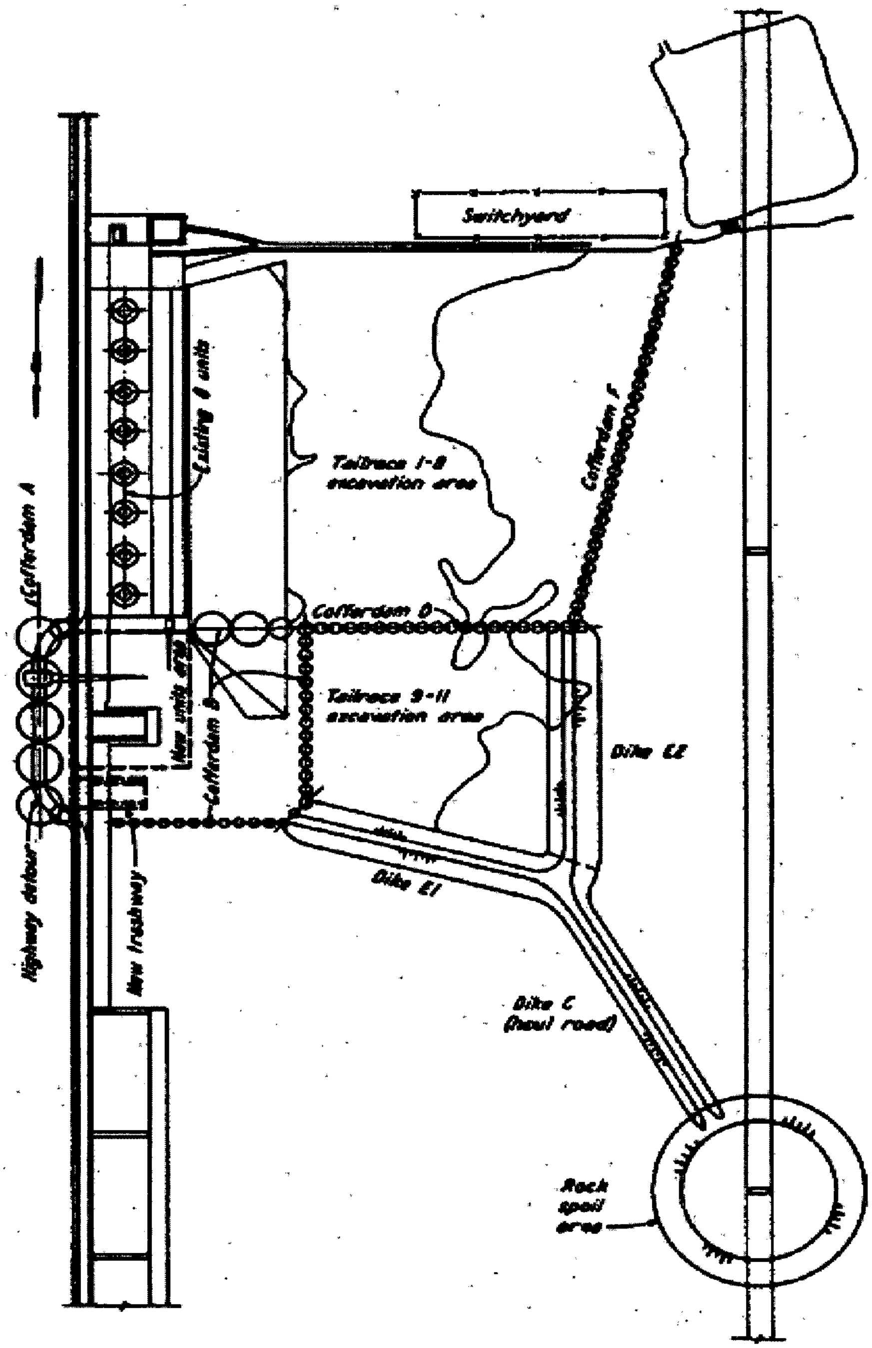
* Structural work performed as separate project

CONSTRUCTION SCHEDULE - UNITS 3 & 4



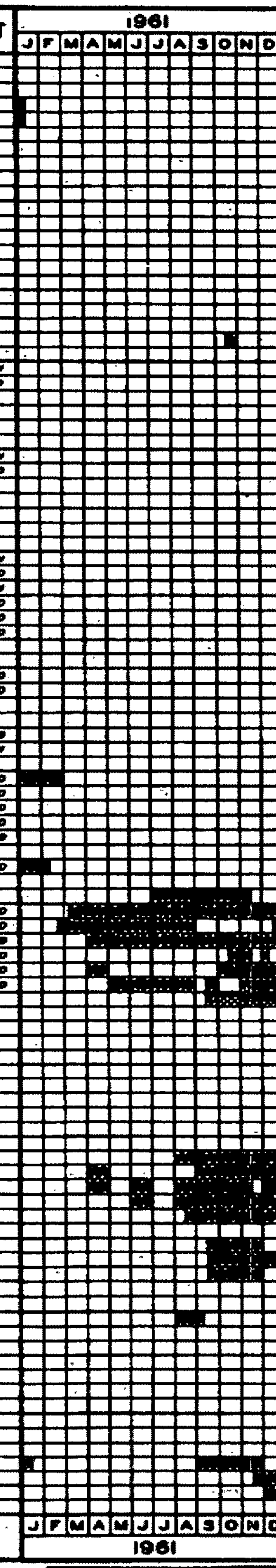
CONSTRUCTION SCHEDULE - UNITS 5, 6, 7 & 8

DETAILED CONSTRUCTION
LAYOUT - UNITS 9 - 11



COMMERCIAL OPERATION DATES:
Unit 9 - Dec. 21, 1962
" 10 - June 5, 1963
" 11 - Dec. 18, 1963
Project Closed - May 30, 1964.

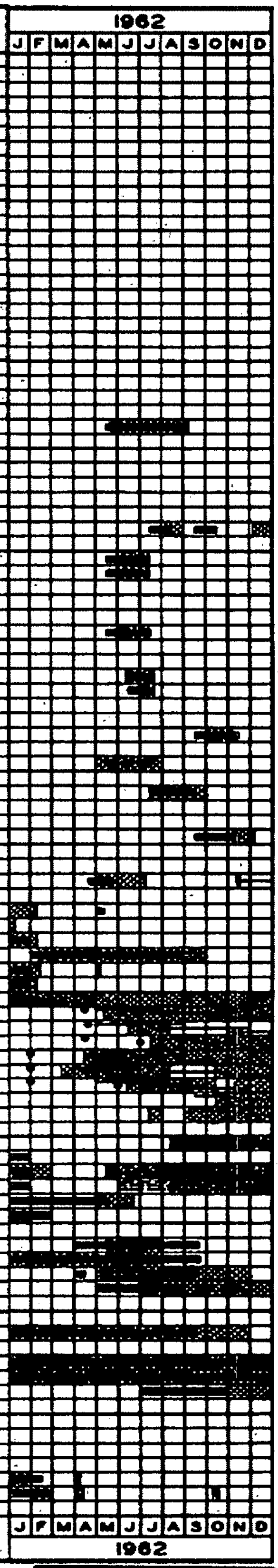
		NO	ITEM	QUAN	UNIT
CONSTRUCTION PLANT	BUILDINGS AND SHOPS	1	WAREHOUSE		
		2	EQUIPMENT, PIPE, IRON SHOP		
		3	ELECTRIC SHOP		
		4	CARPENTER SHOP		
		5	REINFORCING IRON SHOP		
		6	DRILL SHOP		
		7	COMPRESSOR		
		8	FOREMEN AND ENGINEERS		
		9	MISCELLANEOUS BUILDINGS		
		10			
	UTILITIES	11	COMPRESSED AIR		
		12	RAW WATER		
		13	POWER AND LIGHTING		
		14	TELEPHONE		
		15			
	OTHER	16	CHANNEL MARKING		
		17	PARKING LOTS		
		18	100 TON STIFFLEG DERRICK - LOWER YARD		
		19	45 TON GANTRY ON UPPER COFFERDAM		
		20	20 TON GANTRY ON DRAFT TUBE DECK		
		21			
COFFERDAMS AND DIKES	COFFERDAM A UPSTREAM	22	SET SHEET PILING - 8 CELLS 70 FT DIAM	1,400	TON
		23	FILL 8 CELLS	62,000	CU YD
		24	CONNECTIONS TO DAM		
		25	SET PUMPS AND UNWATER		
		26	REMOVE COFFERDAM		
		27			
	COFFERDAM B DOWNSTREAM	28	SET PILING - 30 CELLS	720	TON
		29	FILL 30 CELLS	15,000	CU YD
		30	CONNECTIONS TO DRAFT TUBE DECK		
		31	TIMBER CRIB		
		32	SET PUMPS AND UNWATER		
		33	REMOVE COFFERDAM		
		34			
	COFFERDAMS D AND F AND DIKE E TAILRACE	35	SET PILING - 20 CELLS 18 FT DIAM - COFFERDAM D	370	TON
		36	FILL 20 CELLS	4,000	CU YD
		37	SET PILING - 31 CELLS 18 FT DIAM - COFFERDAM F	500	TON
		38	FILL 31 CELLS	7,000	CU YD
		39	BUILD DIKE E1 - FROM EXCAVATION	11,700	CU YD
		40	E2 - FROM STOCKPILE	8,500	CU YD
		41			
		42			
		43	BLANKET DIKE E1	4,000	CU YD
		44	E2	3,000	CU YD
		45			
		46			
		47	REMOVE DIKE E	20,000	CU YD
		48	REMOVE COFFERDAMS D AND F	860	TON
		49	UNITS 1-8 OUTAGE - PARTIAL SHOWN DOTTED		
POWERHOUSE	ROCK EXCAVATION	50	UNIT AND TRASHWAY AREA	55,000	CU YD
		51	TAILRACE - UNITS 9-11	6,000	CU YD
		52	- UNITS 1-8 - TO SOUTH SHORE SPOIL	13,500	CU YD
		53	BUILD HAUL ROAD TO SPOIL AREA	6,000	CU YD
		54	REMOVE HAUL ROAD TO SPOIL AREA	6,000	CU YD
	CONCRETE REMOVAL	55	REROUTE CIRCUITS FROM SPILLWAY GALLERY		
		56	NO. DAM FOR INTAKES AND TRASHWAY	20,000	CU YD
		57	END WALLS FOR GALLERY EXTENSION		
		58	END UNIT 8 FOR 8 & 9 DECKS		
	CONCRETE PLACEMENT	59	INTAKE	15,500	CU YD
		60	POWERHOUSE - STAGE 1A - DRAFT TUBE DECK	8,000	CU YD
		61	- STAGE 1B - DRAFT TUBE AND SCROLL CASE WALLS	22,000	CU YD
		62	- STAGE 2	6,500	CU YD
		63	DECKS BETWEEN UNITS 8 & 9	1,000	CU YD
		64	TRASHWAY	3,200	CU YD
	TURBINES	65	EMBEDDED DOORS, LINERS, RINGS		
		66	COVERS, GATES AND OPERATING EQUIPMENT		
		67	RUNNER AND SHAFT		
		68	BEARING AND MISCELLANEOUS		
	GENERATORS	69	LOWER BRACKET AND SHAFT		
		70	ROTOR		
		71	STATOR		
		72	UPPER BRACKET AND EXCITER		
		73	HOUSING AND MISCELLANEOUS		
		74			
	OTHER EQUIPMENT	75	GOVERNORS		
		76	EXTENSION OF CRANE RAILS AND TROLLEYS		
		77	INTAKE GATE GUIDES - GATES IN SERVICE DOTTED		
		78	DRAFT TUBE GATE GUIDES - GATES IN SERVICE DOTTED		
		79	TRASHRACKS AND GUIDES		
		80	TRASHGATE AND GUIDES		
		81			
	TRANSMISSION PLANT	82	RELOCATE 161 KV SPANS - POWERHOUSE TO SWITCHYARD		
		83	REARRANGE 161 KV OCB AND DISCONNECT SWITCHES		
		84	SWITCHING STRUCTURE		
		85	TRANSFORMERS AND SWITCHGEAR		
		86			
	MODIFICATIONS	87	RELOCATE STATION SERVICE TRANSFORMER		
		88	REMOTE CONTROL - UNITS 1-8		
		89			
	OTHER	90	ELECTRICAL AUXILIARIES		
		91	MECHANICAL AUXILIARIES		
		92	ARCHITECTURAL		
		93			
	HIGHWAY BRIDGE	94	BUILD DETOUR ON COFFERDAM		
		95	REROUTE CIRCUITS FROM BRIDGE		
		96	INSTALL TEMPORARY BRIDGE BENT		
		97	FABRICATE BRIDGE STEEL		
		98	SET BRIDGE STEEL		
		99	PLACE CONCRETE SLAB, RAILS, ETC		
		100			



LEGEND:
- Scheduled
- As constructed
- • Expected delivery date

UNITS 9-11
DETAILED CONSTRUCTION SCHEDULE
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY

		NO	ITEM	QUAN	UNIT
CONSTRUCTION PLANT	BUILDINGS AND SHOPS	1	WAREHOUSE		
		2	EQUIPMENT, PIPE, IRON SHOP		
		3	ELECTRIC SHOP		
		4	CARPENTER SHOP		
		5	REINFORCING IRON SHOP		
		6	DRILL SHOP		
		7	COMPRESSOR		
		8	FOREMEN AND ENGINEERS		
		9	MISCELLANEOUS BUILDINGS		
		10			
	UTILITIES	11	COMPRESSED AIR		
		12	RAW WATER		
		13	POWER AND LIGHTING		
		14	TELEPHONE		
		15			
	OTHER	16	CHANNEL MARKING		
		17	PARKING LOTS		
		18	100 TON STIFFLEG DERRICK - LOWER YARD		
		19	45 TON GANTRY ON UPPER COFFERDAM		
		20	20 TON GANTRY ON DRAFT TUBE DECK		
		21			
COFFERDAMS AND DIKES	COFFERDAM A UPSTREAM	22	SET SHEET PILING - 5 CELLS 70 FT DIAM	1,480	TON
		23	FILL 5 CELLS	62,000	CU YD
		24	CONNECTIONS TO DAM		
		25	SET PUMPS AND UNWATER		
		26	REMOVE COFFERDAM		
		27			
	COFFERDAM B DOWNSTREAM	28	SET PILING - 30 CELLS	725	TON
		29	FILL 30 CELLS	16,000	CU YD
		30	CONNECTIONS TO DRAFT TUBE DECK		
		31	TIMBER CRIB		
		32	SET PUMPS AND UNWATER		
		33	REMOVE COFFERDAM		
		34			
	COFFERDAMS D AND F AND DIKE E TAILRACE	35	SET PILING - 20 CELLS 10 FT DIAM - COFFERDAM D	370	TON
		36	FILL 20 CELLS	4,800	CU YD
		37	SET PILING - 31 CELLS 10 FT DIAM - COFFERDAM F	590	TON
		38	FILL 31 CELLS	7,600	CU YD
		39	BUILD DIKE E1 - FROM EXCAVATION	11,700	CU YD
		40	E2 - FROM STOCKPILE	6,300	CU YD
		41			
		42			
		43	BLANKET DIKE E1	4,000	CU YD
		44	E2	8,000	CU YD
		45			
		46			
		47	REMOVE DIKE E	20,000	CU YD
		48	REMOVE COFFERDAMS D AND F	960	TON
		49	UNITS 1-8 OUTAGE - PARTIAL SHOWN DOTTED		
POWERHOUSE	ROCK EXCAVATION	50	UNIT AND TRASHWAY AREA	58,000	CU YD
		51	TAILRACE - UNITS 9-11	6,500	CU YD
		52	- UNITS 1-8 - TO SOUTH SHORE SPOIL	12,000	CU YD
		53	BUILD HAUL ROAD TO SPOIL AREA	6,000	CU YD
		54	REMOVE HAUL ROAD TO SPOIL AREA	6,000	CU YD
	CONCRETE REMOVAL	55	REROUTE CIRCUITS FROM SPILLWAY GALLERY		
		56	MD. DAM FOR INTAKES AND TRASHWAY	20,000	CU YD
		57	END WALLS FOR GALLERY EXTENSION		
		58	END UNIT 8 FOR 8 & 9 DECKS		
	CONCRETE PLACEMENT	59	INTAKE	16,500	CU YD
		60	POWERHOUSE - STAGE 1A - DRAFT TUBE DECK	6,000	CU YD
		61	- STAGE 1B - DRAFT TUBE AND SCROLL CASE WALLS	33,000	CU YD
		62	- STAGE 2	6,500	CU YD
		63	DECKS BETWEEN UNITS 8 & 9	1,800	CU YD
		64	TRASHWAY	3,500	CU YD
	TURBINES	65	EMBEDDED DOORS, LINERS, RINGS		
		66	COVERS, GATES AND OPERATING EQUIPMENT		
		67	RUNNER AND SHAFT		
		68	BEARING AND MISCELLANEOUS		
	GENERATORS	69	LOWER BRACKET AND SHAFT		
		70	ROTOR		
		71	STATOR		
		72	UPPER BRACKET AND EXCITER		
		73	HOUSING AND MISCELLANEOUS		
		74			
	OTHER EQUIPMENT	75	GOVERNORS		
		76	EXTENSION OF CRANE RAILS AND TROLLEYS		
		77	INTAKE GATE GUIDES - GATES IN SERVICE DOTTED		
		78	DRAFT TUBE GATE GUIDES - GATES IN SERVICE DOTTED		
		79	TRASHRACKS AND GUIDES		
		80	TRASHGATE AND GUIDES		
		81			
	TRANSMISSION PLANT	82	RELOCATE 161 KV SPANS - POWERHOUSE TO SWITCHYARD		
		83	REARRANGE 161 KV OCB AND DISCONNECT SWITCHES		
		84	SWITCHING STRUCTURE		
		85	TRANSFORMERS AND SWITCHGEAR		
		86			
	MODIFICATIONS	87	RELOCATE STATION SERVICE TRANSFORMER		
		88	REMOTE CONTROL - UNITS 1-8		
		89			
	OTHER	90	ELECTRICAL AUXILIARIES		
		91	MECHANICAL AUXILIARIES		
		92	ARCHITECTURAL		
		93			
	HIGHWAY BRIDGE	94	BUILD DETOUR ON COFFERDAM		
		95	REROUTE CIRCUITS FROM BRIDGE		
		96	INSTALL TEMPORARY BRIDGE BENT		
		97	FABRICATE BRIDGE STEEL		
		98	SET BRIDGE STEEL		
		99	PLACE CONCRETE SLAB, RAILS, ETC		
		100			



LEGEND:
Scheduled
As constructed
• Expected delivery date

UNITS 9-11
DETAILED CONSTRUCTION SCHEDULE
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY

		NO	ITEM	QUAN	UNIT
CONSTRUCTION PLANT	BUILDINGS AND SHOPS	1	WAREHOUSE		
		2	EQUIPMENT, PIPE, IRON SHOP		
		3	ELECTRIC SHOP		
		4	CARPENTER SHOP		
		5	REINFORCING IRON SHOP		
		6	DRILL SHOP		
		7	COMPRESSOR		
		8	FOREMEN AND ENGINEERS		
		9	MISCELLANEOUS BUILDINGS		
		10			
	UTILITIES	11	COMPRESSED AIR		
		12	RAW WATER		
		13	POWER AND LIGHTING		
		14	TELEPHONE		
		15			
	OTHER	16	CHANNEL MARKING		
		17	PARKING LOTS		
		18	100 TON STIFFLEG DERRICK - LOWER YARD		
		19	45 TON GANTRY ON UPPER COFFERDAM		
		20	20 TON GANTRY ON DRAFT TUBE DECK		
		21			
COFFERDAMS AND DIKES	COFFERDAM A UPSTREAM	22	SET SHEET PILING - 5 CELLS 70 FT DIAM	1,400	TON
		23	FILL 5 CELLS	65,000	CU YD
		24	CONNECTIONS TO DAM		
		25	SET PUMPS AND UNWATER		
		26	REMOVE COFFERDAM		
		27			
	COFFERDAM B DOWNSTREAM	28	SET PILING - 20 CELLS	725	TON
		29	FILL 20 CELLS	16,800	CU YD
		30	CONNECTIONS TO DRAFT TUBE DECK		
		31	TIMBER CRIB		
		32	SET PUMPS AND UNWATER		
		33	REMOVE COFFERDAM		
		34			
	COFFERDAMS D AND F AND DIKE E TAILRACE	35	SET PILING - 20 CELLS 19 FT DIAM - COFFERDAM D	370	TON
		36	FILL 20 CELLS	4,000	CU YD
		37	SET PILING - 21 CELLS 19 FT DIAM - COFFERDAM F	390	TON
		38	FILL 21 CELLS	7,000	CU YD
		39	BUILD DIKE E1 - FROM EXCAVATION	11,700	CU YD
		40	E2 - FROM STOCKPILE	5,500	CU YD
		41			
		42			
		43	BLANKET DIKE E1	4,000	CU YD
		44	E2	5,000	CU YD
		45			
		46			
		47	REMOVE DIKE E	20,000	CU YD
		48	REMOVE COFFERDAMS D AND F	960	TON
		49	UNITS 1-8 OUTAGE - PARTIAL SHOWN DOTTED		
POWERHOUSE	ROCK EXCAVATION	50	UNIT AND TRASHWAY AREA	55,000	CU YD
		51	TAILRACE - UNITS 9-11	5,000	CU YD
		52	- UNITS 1-8 - TO SOUTH SHORE SPOIL	13,500	CU YD
		53	BUILD HAUL ROAD TO SPOIL AREA	6,000	CU YD
		54	REMOVE HAUL ROAD TO SPOIL AREA	6,000	CU YD
	CONCRETE REMOVAL	55	REROUTE CIRCUITS FROM SPILLWAY GALLERY		
		56	NO. DAM FOR INTAKES AND TRASHWAY	20,000	CU YD
		57	END WALLS FOR GALLERY EXTENSION		
		58	END UNIT 8 FOR 8 & 9 DECKS		
	CONCRETE PLACEMENT	59	INTAKE	10,500	CU YD
		60	POWERHOUSE - STAGE IA - DRAFT TUBE DECK	6,000	CU YD
		61	- STAGE IB - DRAFT TUBE AND SCROLL CASE WALLS	23,000	CU YD
		62	- STAGE 2	4,500	CU YD
		63	DECKS BETWEEN UNITS 8 & 9	1,000	CU YD
		64	TRASHWAY	3,200	CU YD
	TURBINES	65	EMBEDDED DOORS, LINERS, RINGS		
		66	COVERS, GATES AND OPERATING EQUIPMENT		
		67	RUNNER AND SHAFT		
		68	BEARING AND MISCELLANEOUS		
	GENERATORS	69	LOWER BRACKET AND SHAFT		
		70	ROTOR		
		71	STATOR		
		72	UPPER BRACKET AND EXCITER		
		73	HOUSING AND MISCELLANEOUS		
		74			
	OTHER EQUIPMENT	75	GOVERNORS		
		76	EXTENSION OF CRANE RAILS AND TROLLEYS		
		77	INTAKE GATE GUIDES - GATES IN SERVICE DOTTED		
		78	DRAFT TUBE GATE GUIDES - GATES IN SERVICE DOTTED		
		79	TRASHRACKS AND GUIDES		
		80	TRASHGATE AND GUIDES		
		81			
	TRANSMISSION PLANT	82	RELOCATE 161 KV SPANS - POWERHOUSE TO SWITCHYARD		
		83	REARRANGE 161 KV OCB AND DISCONNECT SWITCHES		
		84	SWITCHING STRUCTURE		
		85	TRANSFORMERS AND SWITCHGEAR		
		86			
	MODIFICATIONS	87	RELOCATE STATION SERVICE TRANSFORMER		
		88	REMOTE CONTROL - UNITS 1-8		
		89			
	OTHER	90	ELECTRICAL AUXILIARIES		
		91	MECHANICAL AUXILIARIES		
		92	ARCHITECTURAL		
		93			
	HIGHWAY BRIDGE	94	BUILD DETOUR ON COFFERDAM		
		95	REROUTE CIRCUITS FROM BRIDGE		
		96	INSTALL TEMPORARY BRIDGE BENT		
		97	FABRICATE BRIDGE STEEL		
		98	SET BRIDGE STEEL		
		99	PLACE CONCRETE SLAB, RAILS, ETC		
		100			

1963: J F M A M J J A S O N D

OPERATE UNIT 9

OPERATE UNIT 10

OPERATE UNIT 11

J F M A M J J A S O N D

1963

LEGEND:

Scheduled

As constructed

• Expected delivery date

UNITS 9-11

DETAILED CONSTRUCTION SCHEDULE

WHEELER PROJECT

TENNESSEE VALLEY AUTHORITY

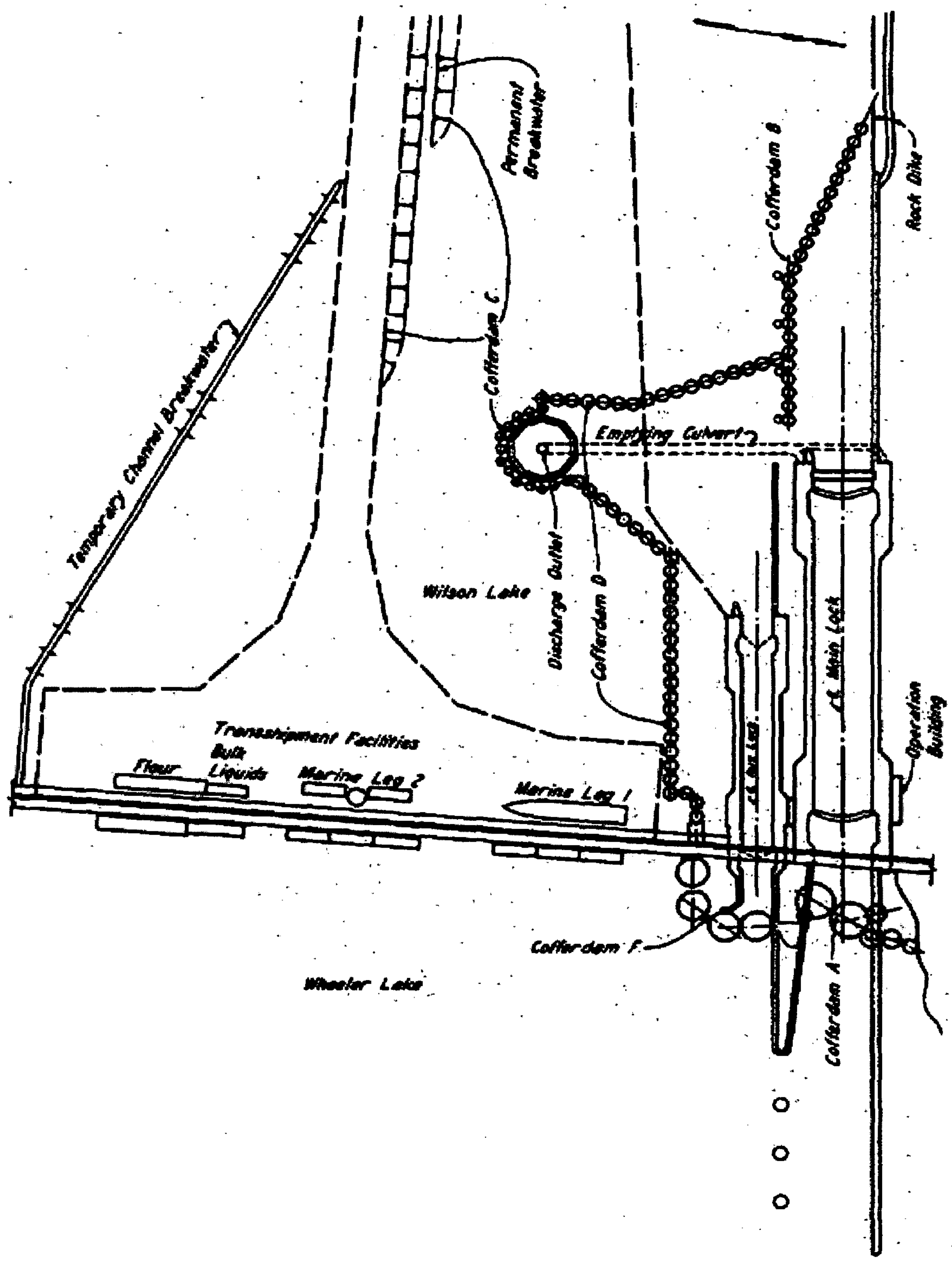
		NO	ITEM	QUAN	UNIT
CONSTRUCTION PLANT	BUILDINGS AND SHOPS	1	WAREHOUSE		
		2	EQUIPMENT, PIPE, IRON SHOP		
		3	ELECTRIC SHOP		
		4	CARPENTER SHOP		
		5	REINFORCING IRON SHOP		
		6	DRILL SHOP		
		7	COMPRESSOR		
		8	FOREMEN AND ENGINEERS		
		9	MISCELLANEOUS BUILDINGS		
		10			
	UTILITIES	11	COMPRESSED AIR		
		12	RAW WATER		
		13	POWER AND LIGHTING		
		14	TELEPHONE		
		15			
	OTHER	16	CHANNEL MARKING		
		17	PARKING LOTS		
		18	100 TON STIFFLEG DERRICK - LOWER YARD		
		19	45 TON GANTRY ON UPPER COFFERDAM		
		20	20 TON GANTRY ON DRAFT TUBE DECK		
		21			
COFFERDAMS AND DIKES	COFFERDAM A UPSTREAM	22	SET SHEET PILING - 5 CELLS 70 FT DIAM	1,400	TON
		23	FILL 5 CELLS	62,000	CU YD
		24	CONNECTIONS TO DAM		
		25	SET PUMPS AND UNWATER		
		26	REMOVE COFFERDAM		
		27			
	COFFERDAM B DOWNSTREAM	28	SET PILING - 30 CELLS	728	TON
		29	FILL 30 CELLS	16,000	CU YD
		30	CONNECTIONS TO DRAFT TUBE DECK		
		31	TIMBER CRIB		
		32	SET PUMPS AND UNWATER		
		33	REMOVE COFFERDAM		
		34			
	COFFERDAMS D AND F AND DIKE E TAILRACE	35	SET PILING - 20 CELLS 40 FT DIAM - COFFERDAM D	370	TON
		36	FILL 20 CELLS	4,000	CU YD
		37	SET PILING - 21 CELLS 40 FT DIAM - COFFERDAM F	380	TON
		38	FILL 21 CELLS	7,600	CU YD
		39	BUILD DIKE E1 - FROM EXCAVATION	11,700	CU YD
		40	E2 - FROM STOCKPILE	6,580	CU YD
		41			
		42			
		43	BLANKET DIKE E1	4,000	CU YD
		44	E2	3,000	CU YD
		45			
		46			
		47	REMOVE DIKE E	20,000	CU YD
		48	REMOVE COFFERDAMS D AND F	960	TON
		49	UNITS 1-8 OUTAGE - PARTIAL SHOWN DOTTED		
POWERHOUSE	ROCK EXCAVATION	50	UNIT AND TRASHWAY AREA	65,000	CU YD
		51	TAILRACE - UNITS 9-11	4,000	CU YD
		52	- UNITS 1-8 - TO SOUTH SHORE SPOIL	13,800	CU YD
		53	BUILD HAUL ROAD TO SPOIL AREA	6,000	CU YD
		54	REMOVE HAUL ROAD TO SPOIL AREA	6,000	CU YD
	CONCRETE REMOVAL	55	REROUTE CIRCUITS FROM SPILLWAY GALLERY		
		56	NO. DAM FOR INTAKES AND TRASHWAY	20,000	CU YD
		57	END WALLS FOR GALLERY EXTENSION		
		58	END UNIT 8 FOR 8 & 9 DECKS		
	CONCRETE PLACEMENT	59	INTAKE	16,500	CU YD
		60	POWERHOUSE - STAGE 1A - DRAFT TUBE DECK	6,000	CU YD
		61	- STAGE 1B - DRAFT TUBE AND SCROLL CASE WALLS	23,000	CU YD
		62	- STAGE 2	4,600	CU YD
		63	DECKS BETWEEN UNITS 8 & 9	1,600	CU YD
		64	TRASHWAY	3,200	CU YD
	TURBINES	65	EMBEDDED DOORS, LINERS, RINGS		
		66	COVERS, GATES AND OPERATING EQUIPMENT		
		67	RUNNER AND SHAFT		
		68	BEARING AND MISCELLANEOUS		
	GENERATORS	69	LOWER BRACKET AND SHAFT		
		70	ROTOR		
		71	STATOR		
		72	UPPER BRACKET AND EXCITER		
		73	HOUSING AND MISCELLANEOUS		
		74			
	OTHER EQUIPMENT	75	GOVERNORS		
		76	EXTENSION OF CRANE RAILS AND TROLLEYS		
		77	INTAKE GATE GUIDES - GATES IN SERVICE DOTTED		
		78	DRAFT TUBE GATE GUIDES - GATES IN SERVICE DOTTED		
		79	TRASHRACKS AND GUIDES		
		80	TRASHGATE AND GUIDES		
		81			
	TRANSMISSION PLANT	82	RELOCATE 161 KV SPANS - POWERHOUSE TO SWITCHYARD		
		83	REARRANGE 161 KV OCB AND DISCONNECT SWITCHES		
		84	SWITCHING STRUCTURE		
		85	TRANSFORMERS AND SWITCHGEAR		
		86			
	MODIFICATIONS	87	RELOCATE STATION SERVICE TRANSFORMER		
		88	REMOTE CONTROL - UNITS 1-8		
		89			
	OTHER	90	ELECTRICAL AUXILIARIES		
		91	MECHANICAL AUXILIARIES		
		92	ARCHITECTURAL		
		93			
	HIGHWAY BRIDGE	94	BUILD DETOUR ON COFFERDAM		
		95	REROUTE CIRCUITS FROM BRIDGE		
		96	INSTALL TEMPORARY BRIDGE BENT		
		97	FABRICATE BRIDGE STEEL		
		98	SET BRIDGE STEEL		
		99	PLACE CONCRETE SLAB, RAILS, ETC		
		100			

1960: F M A M J J A S O N D

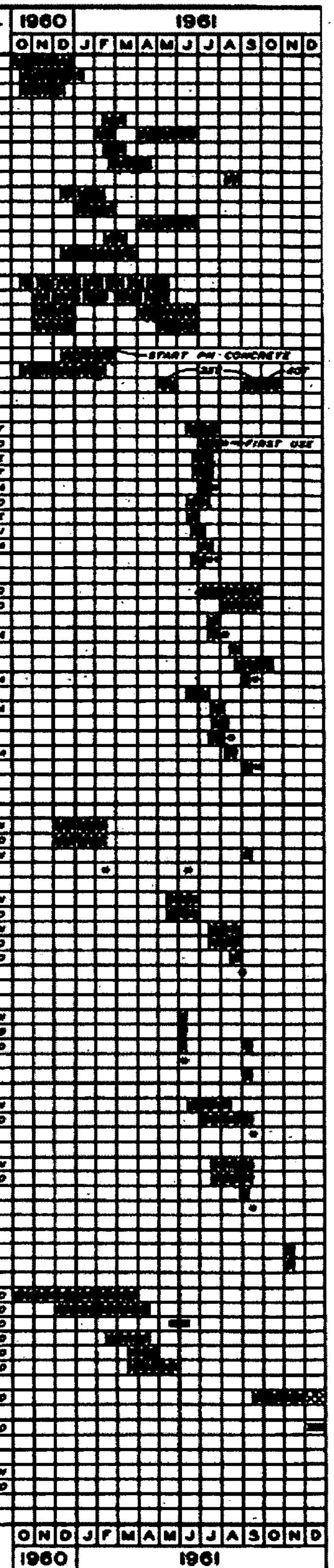
LEGEND:
Scheduled
As constructed
• Expected delivery date

UNITS 9-11
DETAILED CONSTRUCTION SCHEDULE
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY

DETAILED CONSTRUCTION LAYOUT - LOCKS



		NO.	ITEM	QUAN	UNIT
CONSTRUCTION PLANT	ACCESS	1	CLEARING		
		2	ACCESS ROADS & DOCK		
		3	PARKING LOT		
		4			
	BUILDINGS	5	ADMINISTRATION (EXISTING)		
		6	ACCOUNTING & OFFICE ENGINEERS (NURSERY)		
		7	PERSONNEL & TIME OFFICE (EXISTING)		
		8	HOSPITAL (WILSON)		
		9	CONFERENCE (WILSON)		
		10	WAREHOUSE (QUONSET)		
		11	EQUIPMENT SHOP (WILSON)		
		12	MACHINE SHOP (WILSON)		
		13	CONCRETE LAB (EXISTING)		
		14	COMPRESSOR PLANT (WILSON & ADDITION)		
		15			
	UTILITIES	16	COMPRESSED AIR		
		17	POWER & TELEPHONES		
		18	RAW WATER		
		19	TREATED WATER (EXISTING)		
		20			
	OTHER	21	MIXING PLANT		
		22	AGGREGATE STORAGE		
		23	GANTRY CRANES (35T & 40T)		
		24	DERRICK		
		25			
TRANSSHIPMENT FACILITIES	SOUTH SIDE	26	MISSILE & REACTOR ROAD	2,000	LIN FT
		27	MISSILE & REACTOR DOCKS	1,800	CU YD
	NORTH SIDE	28	GASOLINE & OIL - CLEARING & GRADING	7	ACRE
		29	- 12 INCH PIPE	11,000	LIN. FT
		30	- DOCKS	2	EA
		31	TRUCK GRAIN - DREDGING (UNCLASSIFIED)	90,000	CU YD
		32	- CLEARING	8	ACRE
		33	- HAUL ROAD	2.6	MI
		34	- DOCKS	4	EA
		35	- POWER & TELEPHONES		
		36			
	OVER DAM	37	GENERAL - DREDGING (ROCK)	44,000	CU YD
		38	- BREAKWATER	13,000	CU YD
		39	MARINE LEG 1 - OUTFIT & SET		
		40	- WHARVES	2	EA
		41	MARINE LEG 2 - FOUNDATION		
		42	- ERECT		
		43	- WHARVES	2	EA
		44	BULK LIQUIDS - WILSON BOILER PLANT & DOCK		
		45	- WHARVES	2	EA
		46	- PIPING		
		47	- BOILER		
		48	FLOUR - WHARVES	2	EA
		49	- PIPING		
		50			
		51			
COFFERDAMS	B DOWNSTREAM	52			
		53	SET 23 CELLS - 24 FT DIAM	783	TON
		54	FILL CELLS	11,554	CU YD
		55	REMOVE & REPLACE 3 CELLS	85	TON
		56	UNWATER		
		57	FINAL REMOVAL		
	C & D DOWNSTREAM	58	SET 16 CELLS - 16 FT DIAM	240	TON
		59	FILL CELLS	3,872	CU YD
		60	SET 40 CELLS - 24 FT DIAM	1,082	TON
		61	FILL CELLS	12,522	CU YD
		62	PLACE DIKE (C)	1,190	CU YD
		63	UNWATER		
		64	REMOVE		
		65			
	E DOWNSTREAM	66	SET 3 CELLS - 24 FT DIAM	80	TON
		67	FILL CELLS	848	CU YD
		68	PLACE & REMOVE BERM	2,040	CU YD
		69	UNWATER		
		70	REMOVE		
	A UPSTREAM	71			
		72	SET 6 CELLS - 2-70 FT DIAM, 3-38 FT DIAM & 1-24 FT DIAM	856	TON
		73	FILL CELLS	29,906	CU YD
		74	UNWATER		
		75	REMOVE		
	F UPSTREAM	76	SET 4 CELLS - 58 FT DIAM	842	TON
		77	FILL CELLS	20,087	CU YD
		78	CONNECTION TO DAM		
		79	UNWATER		
		80	REMOVE		
	TEMPORARY BULKHEAD	81			
		82	SET & REMOVE AT AUXILIARY LOCK LW FILL PORTS		
		83	SET & REMOVE AT AUXILIARY LOCK RW FILL PORTS		
		84			
PERMANENT CHANNEL	DREDGING	85	REMOVE OVERBURDEN FOR APPROACH DIKE	30,000	CU YD
		86	REMOVE OVERBURDEN FOR CHANNEL	90,000	CU YD
		87	REMOVE ROCK FOR CHANNEL	6,000	CU YD
	OTHER	88	REMOVE EARTH FOR CHANNEL - INSIDE COFFERDAM B	17,000	CU YD
		89	REMOVE ROCK FOR CHANNEL - INSIDE COFFERDAM B	4,000	CU YD
		90	BUILD & DRESS APPROACH DIKE	40,000	CU YD
		91	INSTALL MOORING FACILITY		
		92	PLACE PERMANENT BREAKWATER	50,000	CU YD
		93			
	HIGHWAY BRIDGE	94	NEW PIER - CONCRETE	200	CU YD
		95	REMOVE OLD SLAB, STEEL & BENTS		
		96	ALTER OLD TRUSS PIER		
		97	SET NEW STEEL	185	TON
		98	POUR NEW CONCRETE SLAB	125	CU YD
		99			
		100			



LEGEND:
Scheduled
As constructed

MAIN AND AUXILIARY LOCKS
DETAILED CONSTRUCTION SCHEDULE
SHEET 1
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY

		NO.	ITEM	QUAN	UNIT
EXCAVATION	MAIN LOCK	101	EARTH	60,000	CU YD
		102	ROCK - WALLS & SILLS	70,000	CU YD
		103	- LOWER APPROACH WALLS	2,500	CU YD
		104	- UPPER APPROACH WALLS		
		105	- CULVERT CROSSING	6,000	CU YD
		106	- DISCHARGE VERTICAL SHAFT	1,000	CU YD
		107	- DISCHARGE TUNNEL	7,000	CU YD
		108			
		109	CONCRETE REMOVAL - LW FILL CULVERT	350	CU YD
		110	- RW FILL CULVERT	350	CU YD
		111	- LOCK ENTRANCE	1,600	CU YD
		112			
	AUXILIARY LOCK	113	ROCK - WALLS & SILL	12,000	CU YD
		114	- DISCHARGE OUTLET	1,000	CU YD
		115			
		116	CONCRETE REMOVAL - LW BLOCKS 2-14		
		117	- LW BLOCKS 1 & 15-16		
		118	- RW BLOCKS 27-33	75,000	CU YD
		119	- RW BLOCKS 20-22		
		120	- RW BLOCKS 21 & 34-39		
		121	- CONTROL BUILDING & STORAGE BUILDING		
		122			
CONCRETE	MAIN LOCK	123	LAND WALL - L1-L2	5,500	CU YD
		124	- L3-L15	86,500	CU YD
		125	- L16-L17	18,500	CU YD
		126			
		127			
		128	RIVER WALL - C10-C2	8,000	CU YD
		129	- C3-C10	84,000	CU YD
		130	- C11-C14	18,500	CU YD
		131	- C15-C18	16,500	CU YD
		132	FILL - EMPTY TRENCHES	1,800	CU YD
		133	UPPER SILL - M1-M2	8,500	CU YD
		134	- TRENCH	1,000	CU YD
		135	LOWER SILL - M3-M18	1,800	CU YD
		136	LOWER APPROACH WALLS - L18-L32 & C17	7,000	CU YD
		137	UPPER APPROACH WALLS - BUTTRESS		
		138	- CELL FILL		
		139	- PONTOONS		
		140	FILL CULVERT LINING AT DAM		
		141	CONTROL BUILDING & SHELTERS		
		142	MAINTENANCE BRIDGE SLAB	100	CU YD
		143	DISCHARGE - CULVERT CROSSING	1,200	CU YD
		144	- TUNNEL LINING	1,800	CU YD
		145	- STRUCTURE	1,000	CU YD
	AUXILIARY LOCK	146	LAND WALL - C2-C4	14,800	CU YD
		147	- C5	4,800	CU YD
		148	- C6-C10	26,000	CU YD
		149	RIVER WALL - R2-R4	18,000	CU YD
		150	- R5-R10	27,000	CU YD
		151	CONSOLIDATION & CURTAIN GROUTING		
		152	FILL - EMPTY TRENCHES		
		153	UPPER SILL BUTTRESS		
		154	LOWER SILL & DISCHARGE OUTLET	1,200	CU YD
		155	LOWER APPROACH WALLS C11-C12-R11	1,500	CU YD
		156	EQUIPMENT BUILDING & SHELTERS		
		157	MAINTENANCE BRIDGE SLAB		
		158	VALVE & BULKHEAD SLOTS R1-C1		
		159	RAISE EXISTING RIVER WALL - UPPER END	800	CU YD
		160	RAISE EXISTING LAND WALL - UPPER END	2,000	CU YD
EQUIPMENT	MAIN LOCK	161			
		162	UPPER GATE - ERECT & WELD		
		163	- ALIGN, ADJUST, PAINT		
		164	- OPERATING MACHINERY		
		165			
		166	LOWER GATE - ERECT & WELD		
		167	- ALIGN, ADJUST, PAINT		
		168	- OPERATING MACHINERY		
		169	VALVES - ERECT		
		170	- OPERATING MACHINERY		
		171	OTHER - BULKHEADS & FILLERS - SET AS NOTED		
		172	- MOORING BITTS		
		173	- TOWING EQUIPMENT		
		174	- EMERGENCY DAM - CENTER PIERS		
		175	- TRASHRACKS		
		176	- ELEVATOR		
		177			
	AUXILIARY LOCK	178	UPPER GATE - RECONDITION		
		179	LOWER GATE - ERECT & BOLT		
		180	- ALIGN, ADJUST, PAINT		
		181	- OPERATING MACHINERY		
		182			
		183	VALVES - FILL - ERECT		
		184	- OPERATING MACHINERY		
		185	- EMPTY - ERECT		
		186	- OPERATING MACHINERY		
		187	OTHER - RECONDITION - BULKHEADS - SET AS NOTED - 2 OLD, 3 NEW		
		188	- MOORING BITTS		
		189	- TOWING EQUIPMENT		
	MAIN LOCK OTHER	190	MAINTENANCE BRIDGE STEEL		
		191	HANDRAILS & GRATING		
		192	ARCHITECTURAL INSTALLATIONS		
		193	ELECTRICAL & MECHANICAL INSTALLATIONS		
		194			
	AUXILIARY LOCK OTHER	195	MAINTENANCE BRIDGE STEEL		
		196	HANDRAILS & GRATING		
		197	ARCHITECTURAL INSTALLATIONS		
		198	ELECTRICAL & MECHANICAL INSTALLATIONS		
		199			
		200			

Schedule columns: 1960 (O N D), 1961 (J F M A M J J A S O N D)

MAIN AND AUXILIARY LOCKS
DETAILED CONSTRUCTION SCHEDULE
SHEET 2
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY

		NO.	ITEM	QUAN	UNIT	1982 (J F M A M J J A S O N D)
CONSTRUCTION PLANT	ACCESS	1	CLEARING			
		2	ACCESS ROADS & DOCK			
		3	PARKING LOT			
		4				
	BUILDINGS	5	ADMINISTRATION (EXISTING)			
		6	ACCOUNTING & OFFICE ENGINEERS (NURSERY)			
		7	PERSONNEL & TIME OFFICE (EXISTING)			
		8	HOSPITAL (WILSON)			
		9	CONFERENCE (WILSON)			
		10	WAREHOUSE (QUONSET)			
		11	EQUIPMENT SHOP (WILSON)			
		12	MACHINE SHOP (WILSON)			
		13	CONCRETE LAB (EXISTING)			
		14	COMPRESSOR PLANT (WILSON & ADDITION)			
		15				
	UTILITIES	16	COMPRESSED AIR			
		17	POWER & TELEPHONES			
		18	RAW WATER			
		19	TREATED WATER (EXISTING)			
		20				
	OTHER	21	MIXING PLANT			
		22	AGGREGATE STORAGE			
		23	GANTRY CRANES (35T & 40T)			
		24	DERRICK			
		25				
TRANSSHIPMENT FACILITIES	SOUTH SIDE	26	MISSILE & REACTOR ROAD	5,000	LIN FT	
		27	MISSILE & REACTOR DOCKS	1,500	CU YD	
	NORTH SIDE	28	GASOLINE & OIL - CLEARING & GRADING	7	ACRE	
		29	- 12 INCH PIPE	11,000	LIN FT	
		30	- DOCKS	2	EA	
		31	TRUCK GRAIN - DREDGING (UNCLASSIFIED)	30,000	CU YD	
		32	- CLEARING	6	ACRE	
		33	- HAUL ROAD	2.8	MI	
		34	- DOCKS	4	EA	
		35	- POWER & TELEPHONES			
		36				
	OVER DAM	37	GENERAL - DREDGING (ROCK)	44,000	CU YD	
		38	- BREAKWATER	15,000	CU YD	
		39	MARINE LEG 1 - OUTFIT & SET			
		40	- WHARVES	2	EA	
		41	MARINE LEG 2 - FOUNDATION			
		42	- ERECT			
		43	- WHARVES	2	EA	
		44	BULK LIQUIDS - WILSON BOILER PLANT & DOCK			
		45	- WHARVES	2	EA	
		46	- PIPING			
		47	- BOILER			
		48	FLOUR - WHARVES	2	EA	
		49	- PIPING			
		50				
		51				
COFFERDAMS	B DOWNSTREAM	52				
		53	SET 25 CELLS - 24 FT DIAM	760	TON	
		54	FILL CELLS	11,384	CU YD	
		55	REMOVE & REPLACE 3 CELLS	85	TON	
		56	UNWATER			
		57	FINAL REMOVAL			
	C & D DOWNSTREAM	58	SET 14 CELLS - 16 FT DIAM	340	TON	
		59	FILL CELLS	2,272	CU YD	
		60	SET 48 CELLS - 24 FT DIAM	1,092	TON	
		61	FILL CELLS	16,522	CU YD	
		62	PLACE DIKE (D)	1,100	CU YD	
		63	UNWATER			
		64	REMOVE			
		65				
	E DOWNSTREAM	66	SET 3 CELLS - 24 FT DIAM	80	TON	
		67	FILL CELLS	640	CU YD	
		68	PLACE & REMOVE BERM	2,040	CU YD	
		69	UNWATER			
		70	REMOVE			
		71				
	A UPSTREAM	72	SET 8 CELLS - 2-70 FT DIAM, 5-36 FT DIAM & 1-24 FT DIAM	550	TON	
		73	FILL CELLS	25,600	CU YD	
		74	UNWATER			
		75	REMOVE			
	F UPSTREAM	76	SET 4 CELLS - 58 FT DIAM	642	TON	
		77	FILL CELLS	30,087	CU YD	
		78	CONNECTION TO DAM			
		79	UNWATER			
		80	REMOVE			
		81				
	TEMPORARY BULKHEAD	82	SET & REMOVE AT AUXILIARY LOCK LW FILL PORTS			
		83	SET & REMOVE AT AUXILIARY LOCK RW FILL PORTS			
		84				OPERATE AUX LOCK
PERMANENT CHANNEL	DREDGING	85	REMOVE OVERBURDEN FOR APPROACH DIKE	30,000	CU YD	
		86	REMOVE OVERBURDEN FOR CHANNEL	80,000	CU YD	
		87	REMOVE ROCK FOR CHANNEL	6,000	CU YD	
	OTHER	88	REMOVE EARTH FOR CHANNEL - INSIDE COFFERDAM B	17,000	CU YD	
		89	REMOVE ROCK FOR CHANNEL - INSIDE COFFERDAM B	4,000	CU YD	
		90	BUILD & DRESS APPROACH DIKE	40,000	CU YD	
		91	INSTALL MOORING FACILITY			
		92	PLACE PERMANENT BREAKWATER	50,000	CU YD	
		93				
	HIGHWAY BRIDGE	94	NEW PIER - CONCRETE	300	CU YD	
		95	REMOVE OLD SLAB, STEEL & BENTS			
		96	ALTER OLD TRUSS PIER			
		97	SET NEW STEEL	150	TON	
		98	POUR NEW CONCRETE SLAB	150	CU YD	
		99				
		100				

LEGEND:
Scheduled
As constructed

MAIN AND AUXILIARY LOCKS
DETAILED CONSTRUCTION SCHEDULE
SHEET 1
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY

		NO.	ITEM	QUAN	UNIT	1962 (J F M A M J J A S O N D)
EXCAVATION	MAIN LOCK	101	EARTH	60,000	CU YD	
		102	ROCK - WALLS & SILLS	70,000	CU YD	
		103	- LOWER APPROACH WALLS	3,500	CU YD	
		104	- UPPER APPROACH WALLS			
		105	- CULVERT CROSSING	6,000	CU YD	
		106	- DISCHARGE VERTICAL SHAFT	1,000	CU YD	
		107	- DISCHARGE TUNNEL	7,000	CU YD	
		108				
		109	CONCRETE REMOVAL - LW FILL CULVERT	350	CU YD	
		110	- RW FILL CULVERT	350	CU YD	
		111	- LOCK ENTRANCE	1,600	CU YD	
		112				
	AUXILIARY LOCK	113	ROCK - WALLS & SILL	12,000	CU YD	
		114	- DISCHARGE OUTLET	1,000	CU YD	
		115				
		116	CONCRETE REMOVAL - LW BLOCKS 2-14			
		117	- LW BLOCKS 1 & 15-16			
		118	- RW BLOCKS 27-33	75,000	CU YD	
		119	- RW BLOCKS 20-22			
		120	- RW BLOCKS 21 & 34-39			21
		121	- CONTROL BUILDING & STORAGE BUILDING			CB
		122				
CONCRETE	MAIN LOCK	123	LAND WALL - L1-L2	5,500	CU YD	
		124	- L3-L15	54,300	CU YD	
		125	- L16-L17	18,500	CU YD	
		126				
		127				
		128	RIVER WALL - C10-C2	8,000	CU YD	
		129	- C3-C10	24,000	CU YD	
		130	- C11-C14	18,500	CU YD	
		131	- C15-C16	18,500	CU YD	
		132	FILL - EMPTY TRENCHES	1,800	CU YD	
		133	UPPER SILL - M1-M2	8,300	CU YD	
		134	- TRENCH	4,000	CU YD	
		135	LOWER SILL - M3-M10	1,500	CU YD	
		136	LOWER APPROACH WALLS - L18-L32 & C17	7,000	CU YD	
		137	UPPER APPROACH WALLS - BUTTRESS			
		138	- CELL FILL			
		139	- PONTOONS			
		140	FILL CULVERT LINING AT DAM			
		141	CONTROL BUILDING & SHELTERS			
		142	MAINTENANCE BRIDGE SLAB	100	CU YD	
		143	DISCHARGE - CULVERT CROSSING	1,200	CU YD	
		144	- TUNNEL LINING	1,600	CU YD	
		145	- STRUCTURE	1,000	CU YD	
	AUXILIARY LOCK	146	LAND WALL - C2-C4	14,500	CU YD	
		147	- C5	4,300	CU YD	
		148	- C6-C10	26,000	CU YD	
		149	RIVER WALL - R2-R4	13,000	CU YD	
		150	- R5-R10	27,000	CU YD	
		151	CONSOLIDATION & CURTAIN GROUTING			
		152	FILL - EMPTY TRENCHES			
		153	UPPER SILL BUTTRESS			
		154	LOWER SILL & DISCHARGE OUTLET	1,200	CU YD	
		155	LOWER APPROACH WALLS C11-C12-R11	1,500	CU YD	
		156	EQUIPMENT BUILDING & SHELTERS			
		157	MAINTENANCE BRIDGE SLAB			
		158	VALVE & BULKHEAD SLOTS R1-C1			
		159	RAISE EXISTING RIVER WALL - UPPER END	500	CU YD	
		160	RAISE EXISTING LAND WALL - UPPER END	2,000	CU YD	
EQUIPMENT	MAIN LOCK	161				
		162	UPPER GATE - ERECT & WELD			
		163	- ALIGN, ADJUST, PAINT			
		164	- OPERATING MACHINERY			
		165				
		166	LOWER GATE - ERECT & WELD			
		167	- ALIGN, ADJUST, PAINT			
		168	- OPERATING MACHINERY			
		169	VALVES - ERECT			
		170	- OPERATING MACHINERY			
		171	OTHER - BULKHEADS & FILLERS - SET AS NOTED			US & DS →
		172	- MOORING BITTS			
		173	- TOWING EQUIPMENT			
		174	- EMERGENCY DAM - CENTER PIERS			
		175	- TRASHRACKS			
		176	- ELEVATOR			
		177				
	AUXILIARY LOCK	178	UPPER GATE - RECONDITION			
		179	LOWER GATE - ERECT & BOLT			
		180	- ALIGN, ADJUST, PAINT			
		181	- OPERATING MACHINERY			
		182				← OPERATE AUX LOCK
		183	VALVES - FILL - ERECT			
		184	- OPERATING MACHINERY			
		185	- EMPTY - ERECT			
		186	- OPERATING MACHINERY			
		187	OTHER - RECONDITION - BULKHEADS - SET AS NOTED - 2 OLD, 3 NEW			← LOWER
		188	- MOORING BITTS			UPPER
		189	- TOWING EQUIPMENT			
	MAIN LOCK OTHER	190	MAINTENANCE BRIDGE STEEL			
		191	HANDRAILS & GRATING			
		192	ARCHITECTURAL INSTALLATIONS			
		193	ELECTRICAL & MECHANICAL INSTALLATIONS			
		194				
	AUXILIARY LOCK OTHER	195	MAINTENANCE BRIDGE STEEL			
		196	HANDRAILS & GRATING			
		197	ARCHITECTURAL INSTALLATIONS			
		198	ELECTRICAL & MECHANICAL INSTALLATIONS			
		199				
		200				

J F M A M J J A S O N D
1962

MAIN AND AUXILIARY LOCKS

DETAILED CONSTRUCTION SCHEDULE SHEET 2

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY

FIELD OFFICE | 10-15-61 | [illegible] | 10H1081

		NO.	ITEM	QUAN	UNIT	1963 (J F M A M J J A S O N D)
CONSTRUCTION PLANT	ACCESS	1	CLEARING			
		2	ACCESS ROADS & DOCK			
		3	PARKING LOT			
		4				
	BUILDINGS	5	ADMINISTRATION (EXISTING)			
		6	ACCOUNTING & OFFICE ENGINEERS (NURSERY)			
		7	PERSONNEL & TIME OFFICE (EXISTING)			
		8	HOSPITAL (WILSON)			
		9	CONFERENCE (WILSON)			
		10	WAREHOUSE (QUONSET)			
		11	EQUIPMENT SHOP (WILSON)			
		12	MACHINE SHOP (WILSON)			
		13	CONCRETE LAB (EXISTING)			
		14	COMPRESSOR PLANT (WILSON & ADDITION)			
		15				
	UTILITIES	16	COMPRESSED AIR			
		17	POWER & TELEPHONES			
		18	RAW WATER			
		19	TREATED WATER (EXISTING)			
		20				
	OTHER	21	MIXING PLANT			
		22	AGGREGATE STORAGE			
		23	GANTRY CRANES (25T & 40T)			
		24	DERRICK			
		25				
TRANSSHIPMENT FACILITIES	SOUTH SIDE	26	MISSILE & REACTOR ROAD	3,000	LIN FT	
	NORTH SIDE	27	MISSILE & REACTOR DOCKS	1,200	CU YD	
		28	GASOLINE & OIL - CLEARING & GRADING	7	ACRE	
		29	- 12 INCH PIPE	11,000	LIN FT	
		30	- DOCKS	2	EA	
		31	TRUCK GRAIN - DREDGING (UNCLASSIFIED)	20,000	CU YD	
		32	- CLEARING	8	ACRE	
		33	- HAUL ROAD	2.6	MI	
		34	- DOCKS	4	EA	
		35	- POWER & TELEPHONES			
		36				
	OVER DAM	37	GENERAL - DREDGING (ROCK)	44,000	CU YD	
		38	- BREAKWATER	15,000	CU YD	
		39	MARINE LEG 1 - OUTFIT & SET			
		40	- WHARVES	2	EA	
		41	MARINE LEG 2 - FOUNDATION			
		42	- ERECT			
		43	- WHARVES	2	EA	
		44	BULK LIQUIDS - WILSON BOILER PLANT & DOCK			
		45	- WHARVES	2	EA	
		46	- PIPING			
		47	- BOILER			
		48	FLOUR - WHARVES	2	EA	
		49	- PIPING			
		50				
		51				
COFFERDAMS	B DOWNSTREAM	52				
		53	SET 23 CELLS - 24 FT DIAM	763	TON	
		54	FILL CELLS	11,824	CU YD	
		55	REMOVE & REPLACE 3 CELLS	95	TON	
		56	UNWATER			
		57	FINAL REMOVAL			
	C & D DOWNSTREAM	58	SET 14 CELLS - 16 FT DIAM	240	TON	
		59	FILL CELLS	2,272	CU YD	
		60	SET 46 CELLS - 24 FT DIAM	1,902	TON	
		61	FILL CELLS	12,522	CU YD	
		62	PLACE DIKE (D)	1,100	CU YD	
		63	UNWATER			
		64	REMOVE			
		65				
	E DOWNSTREAM	66	SET 3 CELLS - 24 FT DIAM	80	TON	
		67	FILL CELLS	848	CU YD	
		68	PLACE & REMOVE BERM	2,040	CU YD	
		69	UNWATER			
		70	REMOVE			
	A UPSTREAM	71				
		72	SET 6 CELLS - 2-70 FT DIAM, 3-26 FT DIAM & 1-24 FT DIAM	836	TON	
		73	FILL CELLS	25,806	CU YD	
		74	UNWATER			
		75	REMOVE			
	F UPSTREAM	76	SET 4 CELLS - 58 FT DIAM	842	TON	
		77	FILL CELLS	20,087	CU YD	
		78	CONNECTION TO DAM			
		79	UNWATER			
		80	REMOVE			
	TEMPORARY BULKHEAD	81				
		82	SET & REMOVE AT AUXILIARY LOCK LW FILL PORTS			
		83	SET & REMOVE AT AUXILIARY LOCK RW FILL PORTS			
		84				
PERMANENT CHANNEL	DREDGING	85	REMOVE OVERBURDEN FOR APPROACH DIKE	30,000	CU YD	
		86	REMOVE OVERBURDEN FOR CHANNEL	90,000	CU YD	
		87	REMOVE ROCK FOR CHANNEL	6,000	CU YD	
	OTHER	88	REMOVE EARTH FOR CHANNEL - INSIDE COFFERDAM B	17,000	CU YD	
		89	REMOVE ROCK FOR CHANNEL - INSIDE COFFERDAM B	6,000	CU YD	OPERATE NEW LOCK
		90	BUILD & DRESS APPROACH DIKE	40,000	CU YD	
		91	INSTALL MOORING FACILITY			
		92	PLACE PERMANENT BREAKWATER	30,000	CU YD	
		93				
	HIGHWAY BRIDGE	94	NEW PIER - CONCRETE	200	CU YD	BRIDGE OUT OF SERVICE
		95	REMOVE OLD SLAB, STEEL & BENTS			
		96	ALTER OLD TRUSS PIER			
		97	SET NEW STEEL	165	TON	
		98	POUR NEW CONCRETE SLAB	120	CU YD	
		99				
		100				

J F M A M J J A S O N D
1963

LEGEND:
Scheduled
As constructed

MAIN AND AUXILIARY LOCKS
DETAILED CONSTRUCTION SCHEDULE SHEET 1
WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY

		NO.	ITEM	QUAN	UNIT	1963
EXCAVATION	MAIN LOCK	101	EARTH	60,000	CU YD	
		102	ROCK-WALLS & SILLS	70,000	CU YD	
		103	-LOWER APPROACH WALLS	3,500	CU YD	
		104	-UPPER APPROACH WALLS			
		105	-CULVERT CROSSING	8,000	CU YD	
		106	-DISCHARGE VERTICAL SHAFT	4,000	CU YD	
		107	-DISCHARGE TUNNEL	7,000	CU YD	
		108				
		109	CONCRETE REMOVAL-LW FILL CULVERT	350	CU YD	
		110	-RW FILL CULVERT	350	CU YD	
		111	-LOCK ENTRANCE	4,800	CU YD	
		112				
	AUXILIARY LOCK	113	ROCK-WALLS & SILL	12,000	CU YD	
		114	-DISCHARGE OUTLET	4,000	CU YD	
		115				
		116	CONCRETE REMOVAL-LW BLOCKS 2-14			
		117	-LW BLOCKS 1 & 15-16			
		118	-RW BLOCKS 27-33	78,000	CU YD	
		119	-RW BLOCKS 28-32			
		120	-RW BLOCKS 21 & 34-39			
		121	-CONTROL BUILDING & STORAGE BUILDING			
		122				
CONCRETE	MAIN LOCK	123	LAND WALL-L1-L2	5,500	CU YD	
		124	-L3-L15	36,500	CU YD	
		125	-L16-L17	10,500	CU YD	
		126				
		127				
		128	RIVER WALL-C1D-C2	8,000	CU YD	
		129	-C3-C10	24,000	CU YD	
		130	-C11-C14	10,600	CU YD	
		131	-C15-C16	15,500	CU YD	
		132	FILL-EMPTY TRENCHES	1,500	CU YD	
		133	UPPER SILL-M1-M2	8,500	CU YD	
		134	-TRENCH	1,000	CU YD	
		135	LOWER SILL-M3-M18	1,500	CU YD	
		136	LOWER APPROACH WALLS-L18-L32 & C17	7,000	CU YD	
		137	UPPER APPROACH WALLS-BUTTRESS			
		138	-CELL FILL			
		139	-PONTOONS			
		140	FILL CULVERT LINING AT DAM			
		141	CONTROL BUILDING & SHELTERS			
		142	MAINTENANCE BRIDGE SLAB	100	CU YD	
		143	DISCHARGE-CULVERT CROSSING	1,200	CU YD	
		144	-TUNNEL LINING	1,400	CU YD	
		145	-STRUCTURE	1,000	CU YD	
	AUXILIARY LOCK	146	LAND WALL-C2-C4	14,500	CU YD	
		147	-C5	4,500	CU YD	
		148	-C6-C10	28,000	CU YD	
		149	RIVER WALL-R2-R4	13,000	CU YD	
		150	-R5-R10	27,000	CU YD	
		151	CONSOLIDATION & CURTAIN GROUTING			
		152	FILL-EMPTY TRENCHES			
		153	UPPER SILL BUTTRESS			
		154	LOWER SILL & DISCHARGE OUTLET	1,200	CU YD	
		155	LOWER APPROACH WALLS C11-C12-R11	4,500	CU YD	
		156	EQUIPMENT BUILDING & SHELTERS			
		157	MAINTENANCE BRIDGE SLAB			
		158	VALVE & BULKHEAD SLOTS R1-C1			
		159	RAISE EXISTING RIVER WALL-UPPER END	500	CU YD	
		160	RAISE EXISTING LAND WALL-UPPER END	2,000	CU YD	
EQUIPMENT	MAIN LOCK	161				
		162	UPPER GATE-ERECT & WELD			
		163	-ALIGN, ADJUST, PAINT			
		164	-OPERATING MACHINERY			← OPERATE NEW LOCK
		165				
		166	LOWER GATE-ERECT & WELD			
		167	-ALIGN, ADJUST, PAINT			
		168	-OPERATING MACHINERY			
		169	VALVES-ERECT			
		170	-OPERATING MACHINERY			
		171	OTHER-BULKHEADS & FILLERS-SET AS NOTED			
		172	-MOORING BITTS			
		173	-TOWING EQUIPMENT			
		174	-EMERGENCY DAM-CENTER PIERS			
		175	-TRASHRACKS			
		176	-ELEVATOR			
		177				
	AUXILIARY LOCK	178	UPPER GATE-RECONDITION			
		179	LOWER GATE-ERECT & BOLT			
		180	-ALIGN, ADJUST, PAINT			
		181	-OPERATING MACHINERY			
		182				
		183	VALVES-FILL-ERECT			
		184	-OPERATING MACHINERY			
		185	-EMPTY-ERECT			
		186	-OPERATING MACHINERY			
		187	OTHER-RECONDITION-BULKHEADS-SET AS NOTED-2 OLD, 3 NEW			
		188	-MOORING BITTS			
		189	-TOWING EQUIPMENT			
	MAIN LOCK OTHER	190	MAINTENANCE BRIDGE STEEL			
		191	HANDRAILS & GRATING			
		192	ARCHITECTURAL INSTALLATIONS			
		193	ELECTRICAL & MECHANICAL INSTALLATIONS			
		194				
	AUXILIARY LOCK OTHER	195	MAINTENANCE BRIDGE STEEL			
		196	HANDRAILS & GRATING			
		197	ARCHITECTURAL INSTALLATIONS			
		198	ELECTRICAL & MECHANICAL INSTALLATIONS			
		199				
		200				

1963: J F M A M J J A S O N

MAIN AND AUXILIARY LOCKS

DETAILED CONSTRUCTION SCHEDULE SHEET 2

WHEELER PROJECT
TENNESSEE VALLEY AUTHORITY

CDQ000020080021

Attachment 6

TENNESSEE VALLEY AUTHORITY
RIVER SYSTEM OPERATIONS & ENVIRONMENT
RIVER OPERATIONS

WHEELER DAM

SPILLWAY DISCHARGE TABLES

MARCH 2004

CONTENTS

INSTRUCTIONS FOR USE OF TABLES

1. Tables Update

These tables supersede the tables issued in March 1967. The tables were revised to increase the maximum headwater elevation covered in the tables from 558 feet to 560 feet and to remove the reference to trash gate 3, which no longer exists. The increase in headwater elevation required a change in the maximum gate opening from a fixed 13 feet to an opening designated as "UP," indicating that the bottom of the gate is above the water surface. The tables were revised also to reflect the discharge values obtained from SPILLQ, which is a computer code used in TVA software for monitoring spill discharges and determining gate arrangements.

2. Purpose of Tables

These tables provide a means for setting required spillway discharges and for determining the discharge when a specific arrangement of gates is in use. The tabulated discharges are based on test results from scale models.

The specific gate arrangements in the tables were determined by considering erosion data obtained from spillway model studies together with incremental discharge values for satisfactory spillway operation.

3. Range of Tables

The tables cover a discharge range from 0 to 777,000 cubic feet per second. Headwater elevations range from 548 feet to 560 feet. The tailwater does not affect the discharges from this spillway.

4. Arrangement of Tables

The tables show spillway discharges in cubic feet per second. Headwater elevations in 0.1-foot increments are shown at the top of each column. The headwater range is shown at the bottom of each page.

The discharge is tabulated under the headwater elevations for specific arrangements of gate openings, which are indicated by number in the left and right columns of each page. The numbered arrangements are defined in the table of Spillway Gate Arrangements on pages 5 through 7. Reference to this table and to the drawing showing the location of the gates on page 4 will determine the gate opening to which each gate is to be set for any particular discharge given in the tables.

5. Discharge Intervals

The tables have been prepared so that the incremental discharge between tabulated values for consecutive gate arrangements is generally less than 5 percent of the tabulated discharge. The differences between tabulated discharges caused by a change of one increment in headwater elevation are generally 1 percent or less. These limits are exceeded in some cases near the extreme ends of the tables where operation is relatively infrequent. In general it is possible to set any required discharge within about 2-1/2 percent and to know the actual discharge for any given set of conditions within 1 percent. These tolerances are considered acceptable and therefore it will not be necessary to interpolate between values given in these tables.

When the exact headwater elevation does not appear in the tables, the discharge for the headwater elevation closest to it is used. For example, the column headed 553.1 is used for actual headwater elevations between 553.05 feet and 553.14 feet inclusive. When the actual headwater elevation is exactly halfway between tabular values, the larger value is used.

6. Initial Opening of Spillway Gates

Prior to beginning a spillway gate operation, an observer will inspect the area below the spillway to ensure the area is clear of boats and other unsafe conditions. When an all-clear signal is received from the observer, the gate or gates to be used will be raised to the required gate positions. The observer will remain on the spillway deck and observe the downstream area during the entire period of gate change and will report any unsafe conditions.

7. Raising and Lowering Gates

The gate operating mechanism and controls are located in the gallery at the dam. The controls include electrical switches for raising and lowering individual gates, and master switches for raising and lowering groups of five gates simultaneously. As a gate is raised or lowered, a pointer visible from the control switch indicates the gate opening. Gate opening positions for each foot of opening are marked on the indicator dials and correspond to the openings used in the Spillway Gate Arrangement tables on pages 5 through 7. The opening designated as "UP" specifies that the gate (or gates in a gate group) is opened far enough so that its bottom is above the water surface. This opening is 13 feet for headwater elevations less than or equal to 557.7 feet, 14 feet for headwater elevations greater than 557.7 feet and less than or equal to 559.0 feet, and 15 feet or maximum opening for headwater elevations greater than 559.0 feet.

If the gates are opened in groups of five, the gate opening indicator for each gate should be checked and, if necessary, the gate adjusted with the individual gate control. With the gate opening indicator reading zero, the gate is closed. With the indicator reading 1, 2, 3, 4, 7, 10, 13, 14, or 15 feet, the gate is partially or fully open depending on the headwater elevation.

As shown in the drawing on page 4, the sixty spillway gates are numbered consecutively starting at the powerhouse side of the spillway. As also shown on the drawing, the 12 groups of five gates each are designated by letters assigned to each group.

8. Special Instruction – Preventing Flow Over Top of Spillway Gates When Headwater Elevation is Above 556.28 feet

If the headwater elevation exceeds 556.28 feet (actually, 556.23 feet to provide a 0.05-foot margin of safety) the spillway gates must be set to one of the gate arrangements listed in the tables to prevent flow over the tops of the gates. The minimum gate openings are those corresponding to the lowest numbered gate arrangement for which a discharge value is provided in the tables.

9. Use of Tables

The tables can be used in two ways: (1) to determine the arrangement of gates needed to pass a required discharge at a given headwater elevation, and (2) to determine the discharge for a given arrangement of gates and headwater elevation.

Example 1 -- What gate arrangement is necessary to pass a discharge of 60,500 cubic feet per second with the headwater at elevation 550.62 feet?

The first step is to find the table in which the headwater elevation appears. Referring to the contents page, we find that headwater elevations between 550 feet and 552 feet are found on pages 10 and 11. The headwater elevation closest to 550.62 feet is 550.6 feet. In the column headed 550.6 the discharge nearest to the required 60,500 cubic feet per second is 60,490 cubic feet per second, found near the bottom of page 10. By tracing the horizontal line in which 60,490 cubic feet per second appears, to either side of the page, we find that gate arrangement 52 is the one for producing the discharge closest to 60,500 cubic feet per second at headwater elevation 550.62 feet. Reference to the table of gate arrangements on page 6 shows that the gates and gate groups should be set with the gate opening indicators reading as follows: gate 10 at 4 feet; gate groups D, F, H, J, and L at 4 feet; gates 6, 7, 8, and 9 at zero; and gate groups A, C, E, G, I, and K at zero.

After the gates are opened, changes in the headwater elevation may require changes in the gate arrangement to maintain the desired discharge. For example, if the headwater should fall to 550.44 feet, the discharge will be found in the column headed 550.4. In this column the discharge closest to 60,500 cubic feet per second is 60,840 cubic feet per second for gate arrangement 53. To change to gate arrangement 53 from gate arrangement 52, it is necessary to open gate 9 to gate opening indicator 2 feet.

Example 2 – What gate arrangement is necessary to pass a discharge of 205,000 cubic feet per second with the headwater at elevation 549.63 feet?

The headwater elevation closest to 549.63 feet is 549.6 feet found on pages 8 and 9. In the column headed 549.6 on page 9 the discharge closest to 205,000 cubic feet per second is 203,800 cubic feet per second for gate arrangements 96 through 120. The discharge is the same for all of these gate arrangements because for headwater elevation 549.6 feet all gates set to indicator readings 7, 10, and 13 feet ("UP" is 13 feet for this headwater) are raised above the water surface. While any of gate arrangements 96 through 120 could be used to pass the desired discharge, the lowest gate arrangement, number 96, should be used so that fewer gate changes will be required if the headwater elevation should rise and it is desired to maintain the same discharge. Reference to the table of gate arrangements on page 7 shows that the gate groups should all be set to gate opening indicator readings of 7 feet for gate arrangement 96.

Example 3 -- Suppose the operating records show that the headwater is at elevation 554.65 feet and gate arrangement 49 is in use. The headwater is found on page 14, which is marked "Headwater 554 to 556." The elevation given is exactly halfway between elevations 554.6 feet and 554.7 feet. The larger value, 554.7 feet, should be used. In the column headed 554.7, opposite gate arrangement 49, the discharge is found to be 72,040 cubic feet per second.

10. Trash Gates

Discharge tables for trash gates 1 and 2 are given on page 19. As shown in the drawing on page 4, trash gate 1 is located in the non-overflow section of the dam between the powerhouse and the spillway. Trash gate 2 is located in the non-overflow section between the navigation locks and the spillway. Discharge passes over the tops of these gates and is increased by lowering the gates. In the closed, fully raised, position, the tops of the trash gates are at elevation 556.28 feet. Gate position indicators marked in 1-foot increments are located in the control gallery near the operating controls. Fractional gate openings should not be set. Gate indicator reading 0 corresponds to a fully lowered trash gate, positioned for maximum discharge. Gate indicator reading 6 corresponds to a fully raised trash gate (6 feet above its 0 position) positioned for minimum discharge.

On page 19, discharges are provided for every 0.2-feet increment of headwater elevation and 1-foot increment of gate opening. For headwater elevations greater than 556.28 feet the discharge that occurs when the gates are closed but overflowing is already included in the spillway discharge tables. Consequently, the trash gate discharges on page 19 reflect only the added discharge due to lowering the gates from their fully raised, or closed, positions.

Because trash removal operations are independent of normal spilling operations, the discharge through trash gates 1 and 2 that occurs during trash removal is not included in the spillway discharge tables. The trash removal discharge, which is given in the tables on page 19, must always be added to the discharge obtained from the spillway discharge tables to obtain the total spillway discharge.

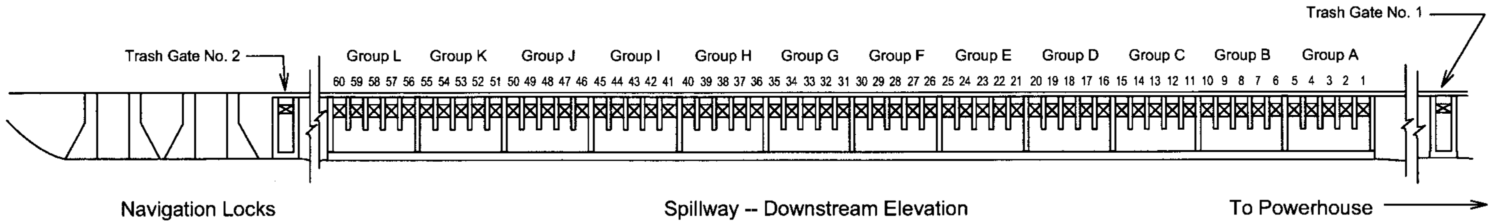
11. Operating Spillway with Unavailable Gates

This section provides guidance for selecting alternative gate arrangements when some gates are unavailable because of maintenance.

For gate arrangements 1 through 60, the gate openings in gate group L may be shifted to group I. Gate openings in all other groups may be shifted one group to the left or one group to the right. For gate arrangements 61 through 76, the gate openings in any one or two groups may be shifted to any available group space so long as not more than 10 consecutive gates are closed at one time. For gate arrangements greater than 76, no simple rules are available.

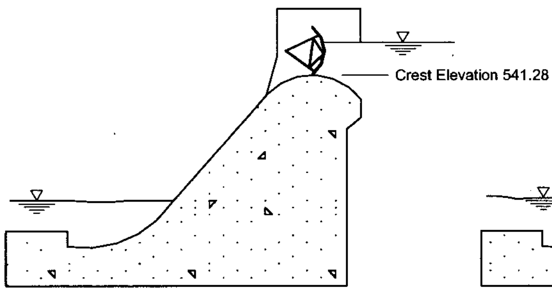
WHEELER DAM

LOCATION OF SPILLWAY GATES & GATE GROUPS



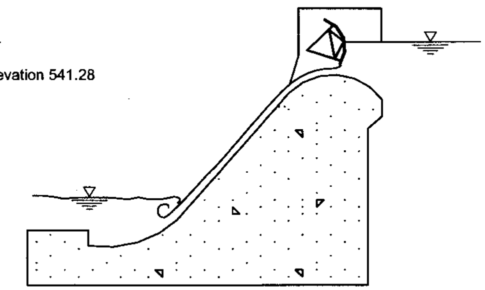
FLOW CONDITIONS ASSOCIATED WITH GATE OPENINGS

(flow conditions for openings 7 and 10 depend on headwater elevation)



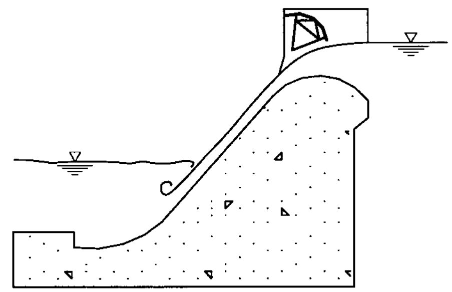
Gate Closed

Gate Position Indicator Number 0



Headwater Above Bottom of Gate

Gate Position Indicator Numbers 1, 2, 3, 4, 7, or 10



Bottom of Gate Raised Above Water Surface

Gate Position Indicator Numbers 7, 10, or UP

GATE NUMBERS, GATE GROUPS, AND GATE OPENINGS:

- Numbers are used in the Spillway Gate Arrangements to refer to single gates while letters are used to refer to five-gate groupings.
- Gate openings referenced in the Spillway Gate Arrangements refer to gate openings in feet as marked on the gate position indicators.
- Gate opening "UP" indicates gate raised above water surface: 13 feet for headwater elevations 557.7 and below, 14 feet for headwater elevations 557.8 to 559.0, and 15 feet for headwater elevations above 559.0.

WHEELER DAM

SPILLWAY GATE ARRANGEMENTS

Arrangement Number	Gate Numbers and Gate Groups																																			
	L					K	J					I	H					G	F					E	D					C	B					A
	60	59	58	57	56	55-51	50	49	48	47	46	45-41	40	39	38	37	36	35-31	30	29	28	27	26	25-21	20	19	18	17	16	15-11	10	9	8	7	6	5-1
1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	4	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	4	4	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	4	4	4	4	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	4	4	4	4	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	4	4	4	4	4	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	4	4	4	4	4	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	4	4	4	4	4	0	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	4	4	4	4	4	0	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	4	4	4	4	4	0	4	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	4	4	4	4	4	0	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	4	4	4	4	4	0	4	4	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	4	4	4	4	4	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	4	4	4	4	4	0	4	4	4	4	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	4	4	4	4	4	0	4	4	4	4	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	4	4	4	4	4	0	4	4	4	4	4	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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25	4	4	4	4	4	0	4	4	4	4	4	0	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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28	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

GATE OPENINGS

Figures in columns under each gate number refer to gate openings in feet marked on the gate indicator dials.

WHEELER DAM

SPILLWAY GATE ARRANGEMENTS

Arrangement Number	Gate Numbers and Gate Groups																																			
	L					K	J					I	H					G	F					E	D					C	B					A
	60	59	58	57	56	55-51	50	49	48	47	46	45-41	40	39	38	37	36	35-31	30	29	28	27	26	25-21	20	19	18	17	16	15-11	10	9	8	7	6	5-1
31	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0
40	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0
41	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	2	0	0	0	0	0	0	0	0	0	0	0
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43	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	2	0	0	0	0	0	0	0	0	0	0
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45	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	2	0	0	0	0	0	0	0	0	0
46	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	0	0	0	0	0	0	0	0	0
47	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	2	0	0	0	0	0	0	0	0
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50	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	0	0	0	0	0	0
51	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	2	0	0	0	0	0
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56	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	0	0	0
57	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	2	0	0
58	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	0	0
59	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	2	0
60	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0	4	4	4	4	4	0

GATE OPENINGS

Figures in columns under each gate number refer to gate openings in feet marked on the gate indicator dials.

WHEELER DAM

SPILLWAY GATE ARRANGEMENTS

Arrangement Number	Gate Numbers and Gate Groups											
	L	K	J	I	H	G	F	E	D	C	B	A
	60-56	55-51	50-46	45-41	40-36	35-31	30-26	25-21	20-16	15-11	10-6	5-1
61	4	1	4	0	4	0	4	0	4	0	4	0
62	4	2	4	0	4	0	4	0	4	0	4	0
63	4	3	4	0	4	0	4	0	4	0	4	0
64	4	4	4	0	4	0	4	0	4	0	4	0
65	4	4	4	1	4	0	4	0	4	0	4	0
66	4	4	4	2	4	0	4	0	4	0	4	0
67	4	4	4	3	4	0	4	0	4	0	4	0
68	4	4	4	4	4	0	4	0	4	0	4	0
69	4	4	4	4	4	1	4	0	4	0	4	0
70	4	4	4	4	4	2	4	0	4	0	4	0
71	4	4	4	4	4	3	4	0	4	0	4	0
72	4	4	4	4	4	4	4	0	4	0	4	0
73	4	4	4	4	4	4	4	1	4	0	4	0
74	4	4	4	4	4	4	4	2	4	0	4	0
75	4	4	4	4	4	4	4	3	4	0	4	0
76	4	4	4	4	4	4	4	4	4	0	4	0
77	4	4	4	4	4	4	4	4	4	1	4	0
78	4	4	4	4	4	4	4	4	4	2	4	0
79	4	4	4	4	4	4	4	4	4	3	4	0
80	4	4	4	4	4	4	4	4	4	4	4	0
81	4	4	4	4	4	4	4	4	4	4	4	1
82	4	4	4	4	4	4	4	4	4	4	4	2
83	4	4	4	4	4	4	4	4	4	4	4	3
84	4	4	4	4	4	4	4	4	4	4	4	4
85	7	4	4	4	4	4	4	4	4	4	4	4
86	7	4	7	4	4	4	4	4	4	4	4	4
87	7	4	7	4	7	4	4	4	4	4	4	4
88	7	4	7	4	7	4	7	4	4	4	4	4
89	7	4	7	4	7	4	7	4	7	4	4	4
90	7	4	7	4	7	4	7	4	7	4	7	4

Arrangement Number	Gate Numbers and Gate Groups											
	L	K	J	I	H	G	F	E	D	C	B	A
	60-56	55-51	50-46	45-41	40-36	35-31	30-26	25-21	20-16	15-11	10-6	5-1
91	7	7	7	4	7	4	7	4	7	4	7	4
92	7	7	7	7	7	4	7	4	7	4	7	4
93	7	7	7	7	7	7	7	4	7	4	7	4
94	7	7	7	7	7	7	7	7	7	4	7	4
95	7	7	7	7	7	7	7	7	7	7	7	4
96	7	7	7	7	7	7	7	7	7	7	7	7
97	10	7	7	7	7	7	7	7	7	7	7	7
98	10	7	10	7	7	7	7	7	7	7	7	7
99	10	7	10	7	10	7	7	7	7	7	7	7
100	10	7	10	7	10	7	10	7	7	7	7	7
101	10	7	10	7	10	7	10	7	10	7	7	7
102	10	7	10	7	10	7	10	7	10	7	10	7
103	10	10	10	7	10	7	10	7	10	7	10	7
104	10	10	10	10	10	7	10	7	10	7	10	7
105	10	10	10	10	10	10	10	7	10	7	10	7
106	10	10	10	10	10	10	10	10	10	7	10	7
107	10	10	10	10	10	10	10	10	10	10	10	7
108	10	10	10	10	10	10	10	10	10	10	10	10
109	UP	10	10	10	10	10	10	10	10	10	10	10
110	UP	10	UP	10	10	10	10	10	10	10	10	10
111	UP	10	UP	10	UP	10	10	10	10	10	10	10
112	UP	10	UP	10	UP	10	UP	10	10	10	10	10
113	UP	10	UP	10	UP	10	UP	10	UP	10	10	10
114	UP	10	UP	10	UP	10	UP	10	UP	10	UP	10
115	UP	UP	UP	10	UP	10	UP	10	UP	10	UP	10
116	UP	UP	UP	UP	UP	10	UP	10	UP	10	UP	10
117	UP	UP	UP	UP	UP	UP	UP	10	UP	10	UP	10
118	UP	UP	UP	UP	UP	UP	UP	UP	UP	10	UP	10
119	UP	UP	UP	UP	UP	UP	UP	UP	UP	UP	UP	10
120	UP	UP	UP	UP	UP	UP	UP	UP	UP	UP	UP	UP

GATE OPENINGS

Figures in columns under each gate number refer to gate openings in feet marked on the gate indicator dials.

UP = 13 for HW <= 557.7, UP = 14 for 557.7 < HW <= 559.0, UP = 15 for HW > 559.0 (HW = headwater elevation)

WHEELER DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	548.0	548.1	548.2	548.3	548.4	548.5	548.6	548.7	548.8	548.9	549.0	549.1	549.2	549.3	549.4	549.5	549.6	549.7	549.8	549.9	550.0	
1	1,020	1,030	1,040	1,050	1,060	1,070	1,070	1,080	1,090	1,100	1,110	1,120	1,130	1,140	1,140	1,150	1,160	1,170	1,180	1,180	1,190	1
2	1,860	1,880	1,900	1,910	1,930	1,950	1,970	1,990	2,010	2,020	2,040	2,060	2,080	2,100	2,120	2,140	2,160	2,170	2,190	2,210	2,230	2
3	2,880	2,910	2,930	2,960	2,990	3,010	3,040	3,070	3,100	3,130	3,150	3,180	3,210	3,240	3,260	3,290	3,320	3,340	3,370	3,390	3,420	3
4	3,720	3,760	3,790	3,830	3,860	3,890	3,930	3,970	4,010	4,050	4,090	4,130	4,160	4,200	4,240	4,280	4,310	4,350	4,380	4,420	4,450	4
5	4,740	4,790	4,830	4,870	4,920	4,960	5,010	5,060	5,100	5,150	5,200	5,240	5,290	5,340	5,380	5,430	5,470	5,510	5,560	5,600	5,640	5
6	5,580	5,630	5,690	5,740	5,790	5,840	5,900	5,960	6,020	6,070	6,130	6,190	6,250	6,300	6,360	6,410	6,470	6,520	6,570	6,620	6,680	6
7	6,600	6,660	6,730	6,790	6,850	6,910	6,970	7,040	7,110	7,180	7,240	7,310	7,370	7,440	7,500	7,560	7,630	7,690	7,750	7,810	7,870	7
8	7,440	7,510	7,580	7,650	7,720	7,790	7,870	7,940	8,020	8,100	8,180	8,250	8,330	8,400	8,480	8,550	8,620	8,690	8,760	8,830	8,900	8
9	8,460	8,540	8,620	8,700	8,770	8,850	8,940	9,030	9,110	9,200	9,290	9,370	9,450	9,540	9,620	9,700	9,780	9,860	9,940	10,020	10,090	9
10	9,300	9,390	9,480	9,560	9,650	9,730	9,830	9,930	10,030	10,120	10,220	10,320	10,410	10,500	10,600	10,690	10,780	10,860	10,950	11,040	11,130	10
11	10,320	10,420	10,520	10,610	10,700	10,800	10,910	11,010	11,120	11,230	11,330	11,430	11,540	11,640	11,740	11,840	11,940	12,030	12,130	12,220	12,320	11
12	11,160	11,270	11,370	11,480	11,580	11,680	11,800	11,920	12,030	12,150	12,260	12,380	12,490	12,600	12,720	12,830	12,930	13,040	13,140	13,250	13,350	12
13	12,180	12,300	12,410	12,520	12,630	12,750	12,870	13,000	13,130	13,250	13,370	13,500	13,620	13,740	13,860	13,980	14,090	14,210	14,320	14,430	14,540	13
14	13,020	13,150	13,270	13,390	13,510	13,630	13,770	13,900	14,040	14,170	14,310	14,440	14,570	14,700	14,830	14,960	15,090	15,210	15,330	15,450	15,580	14
15	14,040	14,180	14,310	14,440	14,560	14,690	14,840	14,990	15,130	15,280	15,420	15,560	15,700	15,840	15,980	16,120	16,250	16,380	16,510	16,640	16,770	15
16	14,880	15,030	15,160	15,300	15,440	15,580	15,730	15,890	16,050	16,200	16,350	16,500	16,660	16,810	16,950	17,100	17,240	17,380	17,520	17,660	17,800	16
17	15,910	16,060	16,200	16,350	16,490	16,640	16,810	16,970	17,140	17,300	17,460	17,620	17,780	17,940	18,100	18,250	18,400	18,550	18,700	18,850	18,990	17
18	16,750	16,900	17,060	17,210	17,360	17,520	17,700	17,880	18,050	18,220	18,400	18,570	18,740	18,910	19,070	19,240	19,400	19,560	19,710	19,870	20,030	18
19	17,770	17,930	18,100	18,260	18,420	18,590	18,770	18,960	19,140	19,330	19,510	19,690	19,860	20,040	20,220	20,390	20,560	20,720	20,890	21,050	21,220	19
20	18,610	18,780	18,950	19,130	19,290	19,470	19,670	19,860	20,060	20,250	20,440	20,630	20,820	21,010	21,190	21,380	21,550	21,730	21,900	22,080	22,250	20
21	19,630	19,810	19,990	20,170	20,350	20,540	20,740	20,950	21,150	21,350	21,550	21,750	21,950	22,140	22,340	22,530	22,710	22,900	23,080	23,260	23,440	21
22	20,470	20,660	20,850	21,040	21,220	21,420	21,630	21,850	22,060	22,270	22,480	22,690	22,900	23,110	23,310	23,510	23,710	23,900	24,090	24,290	24,480	22
23	21,490	21,690	21,890	22,090	22,280	22,480	22,710	22,930	23,150	23,380	23,590	23,810	24,030	24,240	24,460	24,670	24,870	25,070	25,270	25,470	25,670	23
24	22,330	22,540	22,750	22,950	23,150	23,360	23,600	23,830	24,070	24,300	24,530	24,760	24,980	25,210	25,430	25,650	25,860	26,080	26,290	26,490	26,700	24
25	23,350	23,570	23,780	24,000	24,210	24,430	24,670	24,920	25,160	25,400	25,640	25,870	26,110	26,340	26,570	26,800	27,020	27,240	27,460	27,680	27,890	25
26	24,190	24,420	24,640	24,860	25,080	25,310	25,570	25,820	26,070	26,320	26,570	26,820	27,060	27,310	27,550	27,790	28,020	28,250	28,480	28,700	28,930	26
27	25,210	25,450	25,680	25,910	26,140	26,380	26,640	26,900	27,170	27,420	27,680	27,940	28,190	28,440	28,690	28,940	29,180	29,420	29,650	29,890	30,120	27
28	26,050	26,290	26,540	26,780	27,010	27,260	27,530	27,810	28,080	28,350	28,620	28,880	29,150	29,410	29,670	29,930	30,170	30,420	30,670	30,910	31,150	28
29	27,070	27,320	27,580	27,820	28,070	28,320	28,610	28,890	29,170	29,450	29,730	30,000	30,270	30,540	30,810	31,080	31,330	31,590	31,840	32,090	32,340	29
30	27,910	28,170	28,430	28,690	28,940	29,200	29,500	29,790	30,080	30,370	30,660	30,950	31,230	31,510	31,790	32,060	32,330	32,590	32,860	33,120	33,380	30
31	28,930	29,200	29,470	29,740	30,000	30,270	30,570	30,880	31,180	31,470	31,770	32,060	32,360	32,650	32,930	33,220	33,490	33,760	34,030	34,300	34,570	31
32	29,770	30,050	30,330	30,600	30,870	31,150	31,470	31,780	32,090	32,400	32,700	33,010	33,310	33,610	33,910	34,200	34,490	34,770	35,050	35,320	35,600	32
33	30,790	31,080	31,370	31,650	31,930	32,220	32,540	32,860	33,180	33,500	33,810	34,130	34,440	34,750	35,050	35,350	35,650	35,940	36,220	36,510	36,790	33
34	31,630	31,930	32,220	32,510	32,800	33,100	33,430	33,770	34,100	34,420	34,750	35,070	35,390	35,710	36,030	36,340	36,640	36,940	37,240	37,530	37,830	34
35	32,650	32,960	33,260	33,560	33,860	34,160	34,510	34,850	35,190	35,520	35,860	36,190	36,520	36,850	37,170	37,490	37,800	38,110	38,410	38,720	39,020	35
36	33,490	33,810	34,120	34,430	34,730	35,050	35,400	35,750	36,100	36,450	36,790	37,130	37,470	37,810	38,150	38,480	38,800	39,110	39,430	39,740	40,050	36
37	34,510	34,840	35,160	35,470	35,790	36,110	36,470	36,840	37,190	37,550	37,900	38,250	38,600	38,950	39,290	39,630	39,960	40,280	40,600	40,920	41,240	37
38	35,350	35,680	36,010	36,340	36,660	36,990	37,370	37,740	38,110	38,470	38,840	39,200	39,560	39,910	40,270	40,610	40,950	41,290	41,620	41,950	42,280	38
39	36,370	36,710	37,050	37,390	37,720	38,060	38,440	38,820	39,200	39,570	39,950	40,320	40,680	41,050	41,410	41,770	42,110	42,450	42,790	43,130	43,470	39
40	37,210	37,560	37,910	38,250	38,590	38,940	39,330	39,720	40,110	40,500	40,880	41,260	41,640	42,010	42,390	42,750	43,110	43,460	43,810	44,160	44,500	40
41	38,230	38,590	38,950	39,300	39,640	40,010	40,410	40,810	41,210	41,600	41,990	42,380	42,770	43,150	43,530	43,900	44,270	44,630	44,990	45,340	45,690	41
42	39,070	39,440	39,800	40,160	40,520	40,890	41,300	41,710	42,120	42,520	42,920	43,320	43,720	44,110	44,500	44,890	45,260	45,630	46,000	46,360	46,730	42
43	40,090	40,470	40,840	41,210	41,570	41,950	42,370	42,790	43,210	43,620	44,030	44,440	44,850	45,250	45,650	46,040	46,420	46,800	47,180	47,550	47,920	43
44	40,930	41,320	41,700	42,080	42,450	42,830	43,270	43,700	44,120	44,550	44,970	45,390	45,800	46,210	46,620	47,030	47,420	47,800	48,190	48,570	48,950	44
45	41,950	42,350	42,740	43,120	43,500	43,900	44,340	44,780	45,220	45,650	46,080	46,510	46,930	47,350	47,770	48,180	48,580	48,970	49,370	49,760	50,140	45
46	42,790	43,200	43,600	43,990	44,380	44,780	45,230	45,680	46,130	46,570	47,010	47,450	47,880	48,320	48,740	49,160	49,570	49,980	50,380	50,780	51,180	46
47	43,810	44,230	44,630	45,040	45,430	45,850	46,310	46,770	47,220	47,670	48,120	48,570	49,010	49,450	49,890	50,320	50,730	51,150	51,560	51,960	52,370	47
48	44,650	45,080	45,490	45,900	46,310	46,730	47,200	47,670	48,140	48,600	49,060	49,510	49,970	50,420	50,860	51,300	51,730	52,150	52,570	52,990	53,400	48
49	45,680	46,110	46,530	46,950	47,360	47,790	48,270	48,750	49,230	49,700	50,170	50,630	51,090	51,550	52,010	52,450	52,890	53,320	53,750	54,170	54,590	49
50	46,520	46,950	47,390	47,810	48,230	48,670	49,170	49,660	50,140	50,620	51,100	51,580	52,050	52,520	52,980	53,440	53,880	54,320	54,760	55,190	55,630	50
51	47,540	47,980	48,430	48,860	49,290	49,740	50,240	50,740	51,230	51,720	52,210	52,690	53,170	53,650	54,130	54,590	55,040	55,490	55,940	56,380	56,820	51
52	48,380	48,830	49,280	49,730	50,160	50,620	51,130	51,640	52,150	52,650	53,150	53,640	54,130	54,620	55,100	55,580	56,040	56,500	56,950	57,400	57,850	52
53	49,400	49,860	50,320	50,770	51,220	51,690	52,210	52,730	53,240	53,750	54,250	54,760	55,260	55,750	56,240	56,730	57,200	57,660	58,130	58,590	59,040	53
54	50,240	50,710	51,180	51,640	52,090	52,570	53,100	53,630	54,150	54,670	55,190	55,700	56,210	56,720	57,220	57,720	58,190	58,670	59,140	59,610	60,080	54
55	51,260	51,740	52,220	52,690	53,150	53,630	54,170	54,710	55,240	55,770	56,300	56,820	57,340	57,850	58,360	58,870	59,350	59,840	60,320	60,800	61,270	55
56	52,100	52,590	53,070	53,550	54,020	54,510	55,070	55,610	56,160	56,700	57,230	57,770	58,290	58,820	59,340	59,850	60,350	60,840	61,330	61,820	62,300	56
57	53,120	53,620	54,110	54,600	55,080	55,580	56,140	56,700	57,250	57,800	58,340	58,880	59,420	59,950	60,480	61,000	61,510	62,010	62,510	63,000	63,490	57
58	53,960	54,470	54,970	55,460	55,950	56,460	57,030	57,600	58,160	58,720	59,280	59,830	60,380	60,920	61,460	61,990	62,500	63,020	63,520	64,030	64,530	58
59	54,980	55,500	56,010	56,510	57,010	57,530	58,110	58,680	59,260	59,820	60,390	60,950	61,500	62,050	62,600	63,140	63,660	64,180	64,700	65,210	65,720	59
60	55,820	56,340	56,860	57,380	57,880	58,410	59,000	59,590	60,170	60,750	61,320	61,890	62,460	63,020	63,580	64,130	64,660	65,190	65,710	66,230	66,750	60

WHEELER DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	548.0	548.1	548.2	548.3	548.4	548.5	548.6	548.7	548.8	548.9	549.0	549.1	549.2	549.3	549.4	549.5	549.6	549.7	549.8	549.9	550.0	
61	58, 580	59, 130	59, 670	60, 210	60, 730	61, 280	61, 900	62, 500	63, 110	63, 710	64, 300	64, 890	65, 480	66, 060	66, 640	67, 210	67, 760	68, 310	68, 850	69, 390	69, 930	61
62	60, 920	61, 490	62, 060	62, 620	63, 170	63, 740	64, 370	65, 000	65, 630	66, 250	66, 870	67, 480	68, 090	68, 700	69, 300	69, 890	70, 460	71, 030	71, 600	72, 160	72, 720	62
63	63, 140	63, 740	64, 340	64, 920	65, 500	66, 100	66, 760	67, 420	68, 070	68, 720	69, 360	70, 000	70, 640	71, 270	71, 890	72, 500	73, 100	73, 690	74, 280	74, 860	75, 440	63
64	65, 120	65, 740	66, 340	66, 940	67, 530	68, 140	68, 830	69, 520	70, 200	70, 870	71, 540	72, 210	72, 870	73, 520	74, 170	74, 820	75, 440	76, 050	76, 660	77, 270	77, 880	64
65	67, 890	68, 520	69, 150	69, 770	70, 380	71, 020	71, 730	72, 430	73, 140	73, 830	74, 520	75, 210	75, 890	76, 560	77, 240	77, 900	78, 540	79, 170	79, 810	80, 430	81, 060	65
66	70, 220	70, 890	71, 540	72, 180	72, 810	73, 470	74, 210	74, 940	75, 660	76, 380	77, 090	77, 800	78, 500	79, 200	79, 890	80, 580	81, 240	81, 890	82, 550	83, 200	83, 840	66
67	72, 440	73, 130	73, 810	74, 490	75, 150	75, 830	76, 600	77, 350	78, 100	78, 850	79, 580	80, 320	81, 050	81, 770	82, 490	83, 190	83, 870	84, 550	85, 230	85, 900	86, 560	67
68	74, 420	75, 130	75, 820	76, 500	77, 180	77, 880	78, 670	79, 450	80, 230	81, 000	81, 760	82, 520	83, 280	84, 030	84, 770	85, 500	86, 210	86, 920	87, 620	88, 310	89, 000	68
69	77, 190	77, 910	78, 630	79, 330	80, 030	80, 750	81, 560	82, 370	83, 160	83, 960	84, 740	85, 520	86, 300	87, 070	87, 830	88, 590	89, 320	90, 040	90, 760	91, 470	92, 180	69
70	79, 530	80, 280	81, 010	81, 740	82, 460	83, 210	84, 040	84, 870	85, 690	86, 500	87, 310	88, 110	88, 910	89, 700	90, 490	91, 260	92, 010	92, 760	93, 500	94, 240	94, 970	70
71	81, 740	82, 520	83, 290	84, 050	84, 790	85, 570	86, 430	87, 280	88, 130	88, 970	89, 810	90, 630	91, 460	92, 270	93, 080	93, 880	94, 650	95, 420	96, 180	96, 940	97, 690	71
72	83, 730	84, 520	85, 300	86, 060	86, 820	87, 610	88, 500	89, 380	90, 250	91, 120	91, 980	92, 840	93, 690	94, 530	95, 370	96, 190	96, 990	97, 780	98, 570	99, 350	100, 100	72
73	86, 490	87, 300	88, 100	88, 900	89, 680	90, 490	91, 400	92, 300	93, 190	94, 080	94, 960	95, 840	96, 710	97, 570	98, 430	99, 270	100, 100	100, 900	101, 700	102, 500	103, 300	73
74	88, 830	89, 670	90, 490	91, 310	92, 110	92, 940	93, 870	94, 800	95, 720	96, 630	97, 530	98, 430	99, 320	100, 200	101, 100	102, 000	102, 800	103, 600	104, 500	105, 300	106, 100	74
75	91, 050	91, 910	92, 770	93, 610	94, 440	95, 300	96, 260	97, 210	98, 160	99, 090	100, 000	100, 900	101, 900	102, 800	103, 700	104, 600	105, 400	106, 300	107, 100	108, 000	108, 800	75
76	93, 030	93, 910	94, 770	95, 630	96, 470	97, 350	98, 330	99, 310	100, 300	101, 200	102, 200	103, 200	104, 100	105, 000	106, 000	106, 900	107, 800	108, 600	109, 500	110, 400	111, 300	76
77	95, 790	96, 690	97, 580	98, 460	99, 320	100, 200	101, 200	102, 200	103, 200	104, 200	105, 200	106, 200	107, 100	108, 100	109, 000	110, 000	110, 900	111, 800	112, 700	113, 600	114, 400	77
78	98, 130	99, 060	99, 970	100, 900	101, 800	102, 700	103, 700	104, 700	105, 700	106, 800	107, 800	108, 700	109, 700	110, 700	111, 700	112, 600	113, 600	114, 500	115, 400	116, 300	117, 200	78
79	100, 400	101, 300	102, 200	103, 200	104, 100	105, 000	106, 100	107, 100	108, 200	109, 200	110, 200	111, 300	112, 300	113, 300	114, 300	115, 300	116, 200	117, 100	118, 100	119, 000	119, 900	79
80	102, 300	103, 300	104, 300	105, 200	106, 100	107, 100	108, 200	109, 200	110, 300	111, 400	112, 400	113, 500	114, 500	115, 500	116, 600	117, 600	118, 500	119, 500	120, 500	121, 400	122, 400	80
81	105, 100	106, 100	107, 100	108, 000	109, 000	110, 000	111, 100	112, 200	113, 200	114, 300	115, 400	116, 500	117, 500	118, 600	119, 600	120, 600	121, 600	122, 600	123, 600	124, 600	125, 600	81
82	107, 400	108, 400	109, 400	110, 400	111, 400	112, 400	113, 500	114, 700	115, 800	116, 900	118, 000	119, 100	120, 100	121, 200	122, 300	123, 300	124, 300	125, 400	126, 400	127, 400	128, 300	82
83	109, 700	110, 700	111, 700	112, 700	113, 700	114, 800	115, 900	117, 100	118, 200	119, 300	120, 500	121, 600	122, 700	123, 800	124, 900	125, 900	127, 000	128, 000	129, 000	130, 100	131, 100	83
84	111, 600	112, 700	113, 700	114, 800	115, 800	116, 800	118, 000	119, 200	120, 300	121, 500	122, 600	123, 800	124, 900	126, 000	127, 200	128, 300	129, 300	130, 400	131, 400	132, 500	133, 500	84
85	114, 400	115, 600	116, 900	118, 100	119, 300	120, 600	122, 000	123, 300	124, 700	126, 100	127, 500	128, 800	130, 200	131, 500	132, 900	134, 200	135, 500	136, 800	138, 100	139, 400	140, 700	85
86	117, 100	118, 500	120, 000	121, 400	122, 900	124, 300	125, 900	127, 500	129, 100	130, 700	132, 300	133, 900	135, 400	137, 000	138, 600	140, 200	141, 700	143, 300	144, 800	146, 400	147, 900	86
87	119, 800	121, 400	123, 100	124, 700	126, 400	128, 100	129, 900	131, 700	133, 500	135, 300	137, 100	138, 900	140, 700	142, 500	144, 300	146, 100	147, 900	149, 700	151, 500	153, 300	155, 100	87
88	122, 500	124, 400	126, 200	128, 100	129, 900	131, 900	133, 900	135, 900	137, 900	139, 900	141, 900	143, 900	146, 000	148, 000	150, 100	152, 100	154, 100	156, 200	158, 200	160, 300	162, 300	88
89	125, 200	127, 300	129, 300	131, 400	133, 500	135, 600	137, 800	140, 000	142, 300	144, 500	146, 700	149, 000	151, 200	153, 500	155, 800	158, 100	160, 300	162, 600	164, 900	167, 200	169, 500	89
90	127, 900	130, 200	132, 500	134, 700	137, 000	139, 400	141, 800	144, 200	146, 600	149, 100	151, 600	154, 000	156, 500	159, 000	161, 500	164, 000	166, 600	169, 100	171, 600	174, 200	176, 700	90
91	130, 600	133, 100	135, 600	138, 100	140, 600	143, 100	145, 700	148, 400	151, 000	153, 700	156, 400	159, 100	161, 800	164, 500	167, 200	170, 000	172, 800	175, 500	178, 300	181, 100	183, 900	91
92	133, 400	136, 000	138, 700	141, 400	144, 100	146, 900	149, 700	152, 500	155, 400	158, 300	161, 200	164, 100	167, 000	170, 000	173, 000	176, 000	179, 000	182, 000	185, 000	188, 100	191, 100	92
93	136, 100	138, 900	141, 800	144, 700	147, 700	150, 600	153, 700	156, 700	159, 800	162, 900	166, 000	169, 100	172, 300	175, 500	178, 700	181, 900	185, 200	188, 400	191, 700	195, 000	198, 400	93
94	138, 800	141, 900	145, 000	148, 100	151, 200	154, 400	157, 600	160, 900	164, 200	167, 500	170, 800	174, 200	177, 600	181, 000	184, 400	187, 900	191, 400	194, 900	198, 400	202, 000	205, 600	94
95	141, 500	144, 800	148, 100	151, 400	154, 800	158, 200	161, 600	165, 100	168, 600	172, 100	175, 600	179, 200	182, 800	186, 500	190, 200	193, 900	197, 600	201, 300	205, 100	208, 900	212, 800	95
96	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	96
97	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	97
98	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	98
99	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	99
100	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	100
101	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	101
102	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	102
103	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	103
104	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	104
105	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	105
106	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	106
107	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	107
108	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	108
109	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	109
110	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	110
111	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	111
112	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	112
113	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	113
114	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	114
115	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	115
116	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	116
117	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	117
118	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	118
119	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	119
120	144, 200	147, 700	151, 200	154, 700	158, 300	161, 900	165, 600	169, 200	172, 900	176, 700	180, 500	184, 300	188, 100	192, 000	195, 900	199, 800	203, 800	207, 800	211, 800	215, 900	220, 000	120

WHEELER DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	550.0	550.1	550.2	550.3	550.4	550.5	550.6	550.7	550.8	550.9	551.0	551.1	551.2	551.3	551.4	551.5	551.6	551.7	551.8	551.9	552.0	
1	1,190	1,200	1,210	1,220	1,220	1,230	1,240	1,250	1,260	1,260	1,270	1,280	1,290	1,290	1,300	1,310	1,310	1,320	1,330	1,340	1,340	1
2	2,230	2,240	2,260	2,280	2,290	2,310	2,330	2,340	2,360	2,380	2,390	2,410	2,420	2,440	2,460	2,470	2,490	2,500	2,520	2,530	2,550	2
3	3,420	3,440	3,470	3,490	3,520	3,540	3,570	3,590	3,620	3,640	3,660	3,690	3,710	3,730	3,760	3,780	3,800	3,830	3,850	3,870	3,890	3
4	4,450	4,480	4,520	4,550	4,590	4,620	4,650	4,690	4,720	4,750	4,780	4,820	4,850	4,880	4,910	4,940	4,980	5,010	5,040	5,070	5,100	4
5	5,640	5,690	5,730	5,770	5,810	5,850	5,890	5,930	5,970	6,020	6,060	6,100	6,130	6,170	6,210	6,250	6,290	6,330	6,370	6,410	6,440	5
6	6,680	6,730	6,780	6,830	6,880	6,930	6,980	7,030	7,080	7,130	7,180	7,220	7,270	7,320	7,370	7,420	7,460	7,510	7,560	7,600	7,650	6
7	7,870	7,930	7,990	8,050	8,100	8,160	8,220	8,280	8,330	8,390	8,450	8,500	8,560	8,610	8,670	8,720	8,780	8,830	8,890	8,940	8,990	7
8	8,900	8,970	9,040	9,100	9,170	9,240	9,310	9,370	9,440	9,500	9,570	9,630	9,700	9,760	9,830	9,890	9,950	10,010	10,080	10,140	10,200	8
9	10,090	10,170	10,250	10,320	10,400	10,470	10,550	10,620	10,690	10,770	10,840	10,910	10,980	11,050	11,130	11,200	11,270	11,340	11,410	11,470	11,540	9
10	11,130	11,210	11,300	11,380	11,460	11,550	11,630	11,710	11,800	11,880	11,960	12,040	12,120	12,200	12,280	12,360	12,440	12,520	12,600	12,670	12,750	10
11	12,320	12,410	12,500	12,600	12,690	12,780	12,870	12,960	13,050	13,140	13,230	13,320	13,410	13,500	13,580	13,670	13,750	13,840	13,930	14,010	14,090	11
12	13,350	13,450	13,560	13,660	13,760	13,860	13,960	14,060	14,160	14,250	14,350	14,450	14,550	14,640	14,740	14,830	14,930	15,020	15,120	15,210	15,300	12
13	14,540	14,650	14,760	14,870	14,980	15,090	15,200	15,310	15,410	15,520	15,620	15,730	15,830	15,940	16,040	16,140	16,240	16,340	16,440	16,540	16,640	13
14	15,580	15,700	15,810	15,930	16,050	16,170	16,280	16,400	16,520	16,630	16,740	16,860	16,970	17,080	17,190	17,310	17,420	17,530	17,640	17,740	17,850	14
15	16,770	16,900	17,020	17,150	17,280	17,400	17,530	17,650	17,770	17,890	18,020	18,140	18,260	18,380	18,490	18,610	18,730	18,850	18,960	19,080	19,190	15
16	17,800	17,940	18,070	18,210	18,340	18,480	18,610	18,740	18,880	19,010	19,140	19,270	19,400	19,520	19,650	19,780	19,900	20,030	20,150	20,280	20,400	16
17	18,990	19,140	19,280	19,430	19,570	19,710	19,850	19,990	20,130	20,270	20,410	20,540	20,680	20,820	20,950	21,090	21,220	21,350	21,480	21,610	21,740	17
18	20,030	20,180	20,330	20,490	20,640	20,790	20,940	21,090	21,230	21,380	21,530	21,670	21,820	21,960	22,110	22,250	22,390	22,530	22,670	22,810	22,950	18
19	21,220	21,380	21,540	21,700	21,860	22,020	22,180	22,330	22,490	22,650	22,800	22,950	23,110	23,260	23,410	23,560	23,710	23,850	24,000	24,150	24,300	19
20	22,250	22,420	22,590	22,760	22,930	23,100	23,260	23,430	23,590	23,760	23,920	24,080	24,240	24,400	24,560	24,720	24,880	25,040	25,190	25,350	25,500	20
21	23,440	23,620	23,800	23,980	24,150	24,330	24,500	24,680	24,850	25,020	25,190	25,360	25,530	25,700	25,860	26,030	26,190	26,360	26,520	26,680	26,850	21
22	24,480	24,660	24,850	25,040	25,220	25,410	25,590	25,770	25,950	26,130	26,310	26,490	26,670	26,840	27,020	27,190	27,370	27,540	27,710	27,880	28,050	22
23	25,670	25,860	26,060	26,250	26,450	26,640	26,830	27,020	27,210	27,400	27,580	27,770	27,950	28,140	28,320	28,500	28,680	28,860	29,040	29,220	29,400	23
24	26,700	26,910	27,110	27,310	27,520	27,720	27,920	28,120	28,310	28,510	28,700	28,900	29,090	29,290	29,480	29,670	29,860	30,040	30,230	30,420	30,600	24
25	27,890	28,110	28,320	28,530	28,740	28,950	29,160	29,360	29,570	29,770	29,980	30,180	30,380	30,580	30,780	30,970	31,170	31,370	31,560	31,750	31,950	25
26	28,930	29,150	29,370	29,590	29,810	30,030	30,240	30,460	30,670	30,890	31,100	31,310	31,520	31,730	31,930	32,140	32,340	32,550	32,750	32,950	33,150	26
27	30,120	30,350	30,580	30,810	31,030	31,260	31,480	31,710	31,930	32,150	32,370	32,590	32,800	33,020	33,230	33,450	33,660	33,870	34,080	34,290	34,500	27
28	31,150	31,390	31,630	31,870	32,100	32,340	32,570	32,800	33,030	33,260	33,490	33,720	33,940	34,170	34,390	34,610	34,830	35,050	35,270	35,490	35,700	28
29	32,340	32,590	32,840	33,080	33,330	33,570	33,810	34,050	34,290	34,520	34,760	34,990	35,230	35,460	35,690	35,920	36,150	36,370	36,600	36,820	37,050	29
30	33,380	33,630	33,890	34,140	34,390	34,650	34,900	35,140	35,390	35,640	35,880	36,120	36,370	36,610	36,850	37,080	37,320	37,560	37,790	38,020	38,260	30
31	34,570	34,830	35,100	35,360	35,620	35,880	36,140	36,390	36,650	36,900	37,150	37,400	37,650	37,900	38,150	38,390	38,630	38,880	39,120	39,360	39,600	31
32	35,600	35,870	36,150	36,420	36,690	36,950	37,220	37,490	37,750	38,010	38,270	38,530	38,790	39,050	39,300	39,560	39,810	40,060	40,310	40,560	40,810	32
33	36,790	37,080	37,360	37,640	37,910	38,190	38,460	38,740	39,010	39,280	39,540	39,810	40,080	40,340	40,600	40,860	41,120	41,380	41,640	41,890	42,150	33
34	37,830	38,120	38,410	38,690	38,980	39,260	39,550	39,830	40,110	40,390	40,670	40,940	41,210	41,490	41,760	42,030	42,300	42,560	42,830	43,090	43,360	34
35	39,020	39,320	39,620	39,910	40,200	40,500	40,790	41,080	41,370	41,650	41,940	42,220	42,500	42,780	43,060	43,340	43,610	43,880	44,160	44,430	44,700	35
36	40,050	40,360	40,670	40,970	41,270	41,570	41,870	42,170	42,470	42,760	43,060	43,350	43,640	43,930	44,210	44,500	44,780	45,070	45,350	45,630	45,910	36
37	41,240	41,560	41,870	42,190	42,500	42,810	43,110	43,420	43,730	44,030	44,330	44,630	44,930	45,220	45,510	45,810	46,100	46,390	46,680	46,960	47,250	37
38	42,280	42,600	42,930	43,250	43,570	43,880	44,200	44,520	44,830	45,140	45,450	45,760	46,060	46,370	46,670	46,970	47,270	47,570	47,870	48,160	48,460	38
39	43,470	43,800	44,130	44,460	44,790	45,120	45,440	45,760	46,080	46,400	46,720	47,040	47,350	47,660	47,970	48,280	48,590	48,890	49,200	49,500	49,800	39
40	44,500	44,840	45,180	45,520	45,860	46,190	46,530	46,860	47,190	47,520	47,840	48,170	48,490	48,810	49,130	49,440	49,760	50,070	50,390	50,700	51,010	40
41	45,690	46,040	46,390	46,740	47,080	47,430	47,770	48,110	48,440	48,780	49,110	49,440	49,770	50,100	50,430	50,750	51,070	51,400	51,710	52,030	52,350	41
42	46,730	47,090	47,440	47,800	48,150	48,500	48,850	49,200	49,550	49,890	50,230	50,570	50,910	51,250	51,580	51,920	52,250	52,580	52,910	53,230	53,560	42
43	47,920	48,290	48,650	49,020	49,380	49,740	50,090	50,450	50,800	51,160	51,510	51,850	52,200	52,540	52,880	53,220	53,560	53,900	54,230	54,570	54,900	43
44	48,950	49,330	49,700	50,070	50,440	50,810	51,180	51,540	51,910	52,270	52,630	52,980	53,340	53,690	54,040	54,390	54,740	55,080	55,430	55,770	56,110	44
45	50,140	50,530	50,910	51,290	51,670	52,050	52,420	52,790	53,160	53,530	53,900	54,260	54,620	54,980	55,340	55,700	56,050	56,400	56,750	57,100	57,450	45
46	51,180	51,570	51,960	52,350	52,740	53,120	53,510	53,890	54,270	54,640	55,020	55,390	55,760	56,130	56,500	56,860	57,220	57,590	57,940	58,300	58,660	46
47	52,370	52,770	53,170	53,570	53,960	54,360	54,750	55,140	55,520	55,910	56,290	56,670	57,050	57,420	57,800	58,170	58,540	58,910	59,270	59,640	60,000	47
48	53,400	53,810	54,220	54,630	55,030	55,430	55,830	56,230	56,630	57,020	57,410	57,800	58,190	58,570	58,950	59,330	59,710	60,090	60,460	60,840	61,210	48
49	54,590	55,010	55,430	55,840	56,260	56,660	57,070	57,480	57,880	58,280	58,680	59,080	59,470	59,860	60,250	60,640	61,030	61,410	61,790	62,170	62,550	49
50	55,630	56,050	56,480	56,900	57,320	57,740	58,160	58,570	58,990	59,390	59,800	60,210	60,610	61,010	61,410	61,810	62,200	62,590	62,980	63,370	63,760	50
51	56,820	57,260	57,690	58,120	58,550	58,970	59,400	59,820	60,240	60,660	61,070	61,490	61,900	62,300	62,710	63,110	63,510	63,910	64,310	64,710	65,100	51
52	57,850	58,300	58,740	59,180	59,620	60,050	60,490	60,920	61,340	61,770	62,190	62,620	63,030	63,450	63,870	64,280	64,690	65,100	65,500	65,910	66,310	52
53	59,040	59,500	59,950	60,400	60,840	61,280	61,730	62,160	62,600	63,030	63,470	63,890	64,320	64,740	65,170	65,590	66,000	66,420	66,830	67,240	67,650	53
54	60,080	60,540	61,000	61,460	61,910	62,360	62,810	63,260	63,700	64,150	64,590	65,020	65,460	65,890	66,320	66,750	67,180	67,600	68,020	68,440	68,860	54
55	61,270	61,740	62,210	62,670	63,130	63,590	64,050	64,510	64,960	65,410	65,860	66,300	66,740	67,180	67,620	68,060	68,490	68,920	69,350	69,780	70,200	55
56	62,300	62,780	63,260	63,730	64,200	64,670	65,140	65,600	66,060	66,520	66,980	67,430	67,880	68,330	68,780	69,220	69,660	70,100	70,540	70,980	71,410	56
57	63,490	63,980	64,470	64,950	65,430	65,900	66,380	66,850	67,320	67,790	68,250	68,710	69,170	69,620	70,080	70,530	70,980	71,430	71,870	72,310	72,750	57
58	64,530	65,020	65,520	66,010	66,500	66,980	67,460	67,940	68,420	68,900	69,370	69,840	70,310	70,770	71,230	71,690	72,150	72,610	73,060	73,510	73,960	58
59	65,720	66,220	66,730	67,220	67,720	68,210	68,700	69,190	69,680	70,160	70,640	71,120	71,590	72,070	72,530	73,000	73,470	73,930	74,390	74,850	75,300	59
60	66,750	67,270	67,780	68,280	68,790	69,290	69,790	70,290	70,780	71,270	71,760	72,250	72,730	73,210	73,690	74,170	74,640	75,110	75,580	76,050	76,510	60

WHEELER DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	550.0	550.1	550.2	550.3	550.4	550.5	550.6	550.7	550.8	550.9	551.0	551.1	551.2	551.3	551.4	551.5	551.6	551.7	551.8	551.9	552.0	
61	69,930	70,460	70,990	71,520	72,040	72,560	73,080	73,600	74,110	74,620	75,130	75,630	76,130	76,630	77,130	77,620	78,110	78,600	79,090	79,570	80,050	61
62	72,720	73,270	73,820	74,370	74,910	75,450	75,990	76,530	77,060	77,590	78,120	78,640	79,160	79,680	80,190	80,700	81,210	81,720	82,220	82,720	83,220	62
63	75,440	76,010	76,580	77,150	77,720	78,280	78,840	79,390	79,950	80,500	81,040	81,590	82,130	82,670	83,200	83,730	84,260	84,790	85,310	85,840	86,350	63
64	77,880	78,480	79,070	79,660	80,250	80,840	81,420	82,000	82,580	83,150	83,720	84,290	84,850	85,410	85,970	86,530	87,080	87,630	88,180	88,720	89,260	64
65	81,060	81,680	82,290	82,900	83,510	84,110	84,720	85,310	85,910	86,500	87,090	87,670	88,260	88,830	89,410	89,980	90,550	91,120	91,680	92,250	92,800	65
66	83,840	84,480	85,120	85,750	86,380	87,000	87,630	88,240	88,860	89,470	90,080	90,680	91,280	91,880	92,470	93,060	93,650	94,240	94,820	95,400	95,970	66
67	86,560	87,220	87,880	88,530	89,180	89,830	90,470	91,110	91,740	92,380	93,000	93,630	94,250	94,870	95,480	96,090	96,700	97,310	97,910	98,510	99,110	67
68	89,000	89,690	90,370	91,050	91,720	92,390	93,050	93,720	94,380	95,030	95,680	96,330	96,980	97,620	98,250	98,890	99,520	100,100	100,800	101,400	102,000	68
69	92,180	92,890	93,590	94,280	94,970	95,660	96,350	97,030	97,710	98,380	99,050	99,720	100,400	101,000	101,700	102,300	103,000	103,600	104,300	104,900	105,600	69
70	94,970	95,690	96,410	97,130	97,840	98,550	99,260	99,960	100,700	101,400	102,000	102,700	103,400	104,100	104,800	105,400	106,100	106,800	107,400	108,100	108,700	70
71	97,690	98,430	99,180	99,910	100,600	101,400	102,100	102,800	103,500	104,300	105,000	105,700	106,400	107,100	107,800	108,500	109,100	109,800	110,500	111,200	111,900	71
72	100,100	100,900	101,700	102,400	103,200	103,900	104,700	105,400	106,200	106,900	107,600	108,400	109,100	109,800	110,500	111,300	112,000	112,700	113,400	114,100	114,800	72
73	103,300	104,100	104,900	105,700	106,400	107,200	108,000	108,700	109,500	110,300	111,000	111,800	112,500	113,200	114,000	114,700	115,400	116,200	116,900	117,600	118,300	73
74	106,100	106,900	107,700	108,500	109,300	110,100	110,900	111,700	112,500	113,200	114,000	114,800	115,500	116,300	117,000	117,800	118,500	119,300	120,000	120,700	121,500	74
75	108,800	109,600	110,500	111,300	112,100	112,900	113,700	114,500	115,300	116,100	116,900	117,700	118,500	119,300	120,000	120,800	121,600	122,300	123,100	123,900	124,600	75
76	111,300	112,100	113,000	113,800	114,600	115,500	116,300	117,100	118,000	118,800	119,600	120,400	121,200	122,000	122,800	123,600	124,400	125,200	126,000	126,700	127,500	76
77	114,400	115,300	116,200	117,000	117,900	118,800	119,600	120,500	121,300	122,100	123,000	123,800	124,600	125,400	126,300	127,100	127,900	128,700	129,500	130,300	131,100	77
78	117,200	118,100	119,000	119,900	120,800	121,600	122,500	123,400	124,300	125,100	126,000	126,800	127,600	128,500	129,300	130,100	131,000	131,800	132,600	133,400	134,200	78
79	119,900	120,900	121,800	122,700	123,600	124,500	125,400	126,300	127,100	128,000	128,900	129,800	130,600	131,500	132,300	133,200	134,000	134,900	135,700	136,500	137,400	79
80	122,400	123,300	124,300	125,200	126,100	127,000	127,900	128,900	129,800	130,700	131,600	132,500	133,300	134,200	135,100	136,000	136,800	137,700	138,600	139,400	140,300	80
81	125,600	126,500	127,500	128,400	129,400	130,300	131,200	132,200	133,100	134,000	134,900	135,800	136,700	137,600	138,500	139,400	140,300	141,200	142,100	142,900	143,800	81
82	128,300	129,300	130,300	131,300	132,200	133,200	134,200	135,100	136,000	137,000	137,900	138,800	139,800	140,700	141,600	142,500	143,400	144,300	145,200	146,100	147,000	82
83	131,100	132,100	133,100	134,100	135,000	136,000	137,000	138,000	138,900	139,900	140,800	141,800	142,700	143,700	144,600	145,500	146,500	147,400	148,300	149,200	150,100	83
84	133,500	134,500	135,600	136,600	137,600	138,600	139,600	140,600	141,600	142,500	143,500	144,500	145,500	146,400	147,400	148,300	149,300	150,200	151,200	152,100	153,000	84
85	140,700	142,000	143,300	144,300	145,300	146,300	147,300	148,300	149,300	150,300	151,300	152,300	153,200	154,200	155,200	156,200	157,200	158,200	159,100	160,100	161,100	85
86	147,900	149,500	151,000	152,100	153,100	154,000	155,000	156,000	157,000	158,000	159,000	160,000	161,000	162,000	163,100	164,100	165,100	166,100	167,100	168,100	169,100	86
87	155,100	156,900	158,700	159,900	160,800	161,800	162,700	163,700	164,700	165,700	166,800	167,800	168,800	169,800	170,900	172,000	173,000	174,100	175,100	176,100	177,100	87
88	162,300	164,400	166,500	167,700	168,600	169,500	170,500	171,400	172,400	173,500	174,500	175,500	176,500	177,600	178,700	179,800	180,900	182,000	183,100	184,100	185,200	88
89	169,500	171,900	174,200	175,400	176,300	177,300	178,200	179,100	180,100	181,200	182,200	183,300	184,300	185,400	186,600	187,700	188,800	190,000	191,100	192,100	193,200	89
90	176,700	179,300	181,900	183,200	184,100	185,000	185,900	186,800	187,800	188,900	190,000	191,000	192,100	193,200	194,400	195,600	196,800	197,900	199,000	200,200	201,300	90
91	183,900	186,800	189,600	191,000	191,800	192,700	193,600	194,500	195,500	196,600	197,700	198,800	199,800	201,000	202,300	203,500	204,700	205,800	207,000	208,200	209,300	91
92	191,100	194,200	197,400	198,700	199,600	200,500	201,300	202,200	203,200	204,400	205,500	206,600	207,600	208,800	210,100	211,300	212,600	213,800	215,000	216,200	217,400	92
93	198,400	201,700	205,100	206,500	207,300	208,200	209,000	209,900	211,000	212,100	213,200	214,300	215,400	216,600	217,900	219,200	220,500	221,700	223,000	224,200	225,400	93
94	205,600	209,200	212,800	214,300	215,100	215,900	216,800	217,600	218,700	219,800	221,000	222,100	223,200	224,400	225,800	227,100	228,400	229,700	231,000	232,200	233,400	94
95	212,800	216,600	220,500	222,100	222,800	223,700	224,500	225,300	226,400	227,500	228,700	229,800	230,900	232,200	233,600	235,000	236,300	237,600	238,900	240,200	241,500	95
96	220,000	224,100	228,300	229,800	230,600	231,400	232,200	233,000	234,100	235,300	236,400	237,600	238,700	240,000	241,500	242,900	244,200	245,600	246,900	248,200	249,500	96
97	220,000	224,100	228,300	230,100	231,100	232,200	233,300	234,400	235,700	237,200	238,600	240,000	241,400	243,000	244,700	246,400	248,000	249,600	251,300	252,900	254,400	97
98	220,000	224,100	228,300	230,300	231,600	233,000	234,400	235,700	237,400	239,100	240,800	242,500	244,200	246,100	248,000	249,900	251,800	253,700	255,600	257,500	259,300	98
99	220,000	224,100	228,300	230,500	232,100	233,800	235,500	237,100	239,000	241,000	243,000	245,000	246,900	249,100	251,200	253,400	255,600	257,800	259,900	262,100	264,200	99
100	220,000	224,100	228,300	230,700	232,600	234,600	236,500	238,500	240,700	242,900	245,200	247,400	249,700	252,100	254,500	257,000	259,400	261,800	264,300	266,700	269,200	100
101	220,000	224,100	228,300	230,900	233,100	235,400	237,600	239,900	242,300	244,800	247,400	249,900	252,400	255,100	257,800	260,500	263,200	265,900	268,600	271,300	274,100	101
102	220,000	224,100	228,300	231,100	233,600	236,200	238,700	241,200	244,000	246,800	249,500	252,300	255,100	258,100	261,000	264,000	267,000	270,000	273,000	276,000	279,000	102
103	220,000	224,100	228,300	231,400	234,100	237,000	239,800	242,600	245,600	248,700	251,700	254,800	257,900	261,100	264,300	267,500	270,800	274,000	277,300	280,600	283,900	103
104	220,000	224,100	228,300	231,600	234,600	237,700	240,900	244,000	247,300	250,600	253,900	257,300	260,600	264,100	267,600	271,100	274,600	278,100	281,700	285,200	288,800	104
105	220,000	224,100	228,300	231,800	235,100	238,500	242,000	245,400	248,900	252,500	256,100	259,700	263,300	267,100	270,800	274,600	278,400	282,200	286,000	289,800	293,700	105
106	220,000	224,100	228,300	232,000	235,700	239,300	243,000	246,800	250,600	254,400	258,300	262,200	266,100	270,100	274,100	278,100	282,200	286,200	290,300	294,500	298,600	106
107	220,000	224,100	228,300	232,200	236,200	240,100	244,100	248,100	252,200	256,300	260,500	264,600	268,800	273,100	277,300	281,600	286,000	290,300	294,700	299,100	303,500	107
108	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	108
109	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	109
110	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	110
111	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	111
112	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	112
113	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	113
114	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	114
115	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	115
116	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	116
117	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	117
118	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	118
119	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	119
120	220,000	224,100	228,300	232,400	236,700	240,900	245,200	249,500	253,900	258,200	262,700	267,100	271,600	276,100	280,600	285,200	289,800	294,400	299,000	303,700	308,400	120

WHEELER DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	552.0	552.1	552.2	552.3	552.4	552.5	552.6	552.7	552.8	552.9	553.0	553.1	553.2	553.3	553.4	553.5	553.6	553.7	553.8	553.9	554.0	
1	1,340	1,350	1,360	1,360	1,370	1,380	1,380	1,390	1,400	1,400	1,410	1,420	1,420	1,430	1,440	1,440	1,450	1,450	1,460	1,470	1,470	1
2	2,550	2,570	2,580	2,600	2,610	2,630	2,640	2,660	2,670	2,690	2,700	2,720	2,730	2,750	2,760	2,770	2,790	2,800	2,820	2,830	2,840	2
3	3,890	3,910	3,940	3,960	3,980	4,000	4,020	4,050	4,070	4,090	4,110	4,130	4,150	4,170	4,200	4,220	4,240	4,260	4,280	4,300	4,320	3
4	5,100	5,130	5,160	5,190	5,220	5,250	5,280	5,310	5,340	5,370	5,400	5,430	5,460	5,490	5,520	5,550	5,580	5,600	5,630	5,660	5,690	4
5	6,440	6,480	6,520	6,560	6,590	6,630	6,670	6,700	6,740	6,780	6,810	6,850	6,880	6,920	6,950	6,990	7,020	7,060	7,090	7,130	7,160	5
6	7,650	7,700	7,740	7,790	7,830	7,880	7,920	7,970	8,010	8,060	8,100	8,150	8,190	8,240	8,280	8,320	8,360	8,410	8,450	8,490	8,530	6
7	8,990	9,050	9,100	9,150	9,200	9,260	9,310	9,360	9,410	9,460	9,510	9,560	9,610	9,660	9,710	9,760	9,810	9,860	9,910	9,960	10,000	7
8	10,200	10,260	10,320	10,390	10,450	10,510	10,570	10,630	10,690	10,750	10,800	10,860	10,920	10,980	11,040	11,100	11,150	11,210	11,260	11,320	11,370	8
9	11,540	11,610	11,680	11,750	11,820	11,880	11,950	12,020	12,080	12,150	12,210	12,280	12,340	12,410	12,470	12,540	12,600	12,660	12,720	12,790	12,850	9
10	12,750	12,830	12,910	12,980	13,060	13,130	13,210	13,280	13,360	13,430	13,510	13,580	13,650	13,730	13,800	13,870	13,940	14,010	14,080	14,150	14,220	10
11	14,090	14,180	14,260	14,340	14,430	14,510	14,590	14,670	14,750	14,830	14,920	15,000	15,080	15,150	15,230	15,310	15,390	15,460	15,540	15,620	15,690	11
12	15,300	15,390	15,490	15,580	15,670	15,760	15,850	15,940	16,030	16,120	16,210	16,300	16,380	16,470	16,560	16,640	16,730	16,810	16,900	16,980	17,060	12
13	16,640	16,740	16,840	16,940	17,040	17,140	17,230	17,330	17,430	17,520	17,620	17,710	17,810	17,900	17,990	18,090	18,180	18,270	18,360	18,450	18,530	13
14	17,850	17,960	18,070	18,170	18,280	18,390	18,490	18,600	18,700	18,800	18,910	19,010	19,110	19,220	19,320	19,420	19,520	19,610	19,710	19,810	19,900	14
15	19,190	19,310	19,420	19,540	19,650	19,760	19,870	19,990	20,100	20,210	20,320	20,430	20,540	20,650	20,750	20,860	20,960	21,070	21,170	21,280	21,380	15
16	20,400	20,530	20,650	20,770	20,890	21,010	21,130	21,250	21,370	21,490	21,610	21,730	21,840	21,960	22,080	22,190	22,300	22,420	22,530	22,640	22,750	16
17	21,740	21,880	22,000	22,130	22,260	22,390	22,520	22,640	22,770	22,890	23,020	23,140	23,270	23,390	23,510	23,630	23,750	23,870	23,990	24,110	24,220	17
18	22,950	23,090	23,230	23,370	23,500	23,640	23,770	23,910	24,040	24,180	24,310	24,440	24,570	24,710	24,840	24,970	25,090	25,220	25,340	25,470	25,590	18
19	24,300	24,440	24,590	24,730	24,870	25,020	25,160	25,300	25,440	25,580	25,720	25,860	26,000	26,140	26,270	26,410	26,540	26,670	26,800	26,930	27,070	19
20	25,500	25,660	25,810	25,960	26,110	26,270	26,420	26,570	26,720	26,860	27,010	27,160	27,310	27,450	27,600	27,740	27,880	28,020	28,160	28,300	28,430	20
21	26,850	27,010	27,170	27,330	27,480	27,640	27,800	27,960	28,110	28,270	28,420	28,570	28,730	28,880	29,030	29,180	29,330	29,470	29,620	29,760	29,910	21
22	28,050	28,220	28,390	28,560	28,730	28,890	29,060	29,220	29,390	29,550	29,710	29,870	30,040	30,200	30,360	30,510	30,670	30,820	30,970	31,130	31,280	22
23	29,400	29,570	29,750	29,920	30,100	30,270	30,440	30,610	30,780	30,950	31,120	31,290	31,460	31,630	31,790	31,960	32,120	32,280	32,440	32,590	32,750	23
24	30,600	30,790	30,970	31,160	31,340	31,520	31,700	31,880	32,060	32,240	32,410	32,590	32,770	32,940	33,120	33,290	33,460	33,620	33,790	33,960	34,120	24
25	31,950	32,140	32,330	32,520	32,710	32,900	33,080	33,270	33,450	33,640	33,820	34,010	34,190	34,370	34,550	34,730	34,910	35,080	35,250	35,420	35,600	25
26	33,150	33,350	33,550	33,750	33,950	34,150	34,340	34,540	34,730	34,920	35,120	35,310	35,500	35,690	35,880	36,060	36,240	36,430	36,610	36,790	36,970	26
27	34,500	34,700	34,910	35,110	35,320	35,520	35,720	35,930	36,130	36,330	36,520	36,720	36,920	37,120	37,310	37,500	37,690	37,880	38,070	38,250	38,440	27
28	35,700	35,920	36,130	36,350	36,560	36,770	36,980	37,190	37,400	37,610	37,820	38,020	38,230	38,430	38,640	38,840	39,030	39,230	39,420	39,620	39,810	28
29	37,050	37,270	37,490	37,710	37,930	38,150	38,370	38,580	38,800	39,010	39,230	39,440	39,650	39,860	40,070	40,280	40,480	40,680	40,880	41,080	41,280	29
30	38,260	38,490	38,720	38,940	39,170	39,400	39,620	39,850	40,070	40,300	40,520	40,740	40,960	41,180	41,400	41,610	41,820	42,030	42,240	42,450	42,650	30
31	39,600	39,840	40,070	40,310	40,540	40,780	41,010	41,240	41,470	41,700	41,930	42,150	42,380	42,610	42,830	43,050	43,270	43,480	43,700	43,910	44,130	31
32	40,810	41,050	41,300	41,540	41,780	42,030	42,270	42,510	42,740	42,980	43,220	43,450	43,690	43,920	44,150	44,380	44,610	44,830	45,050	45,280	45,500	32
33	42,150	42,400	42,650	42,900	43,150	43,400	43,650	43,900	44,140	44,380	44,630	44,870	45,110	45,350	45,590	45,830	46,060	46,290	46,520	46,740	46,970	33
34	43,360	43,620	43,880	44,140	44,400	44,650	44,910	45,160	45,420	45,670	45,920	46,170	46,420	46,670	46,910	47,160	47,400	47,630	47,870	48,110	48,340	34
35	44,700	44,970	45,230	45,500	45,760	46,030	46,290	46,550	46,810	47,070	47,330	47,590	47,840	48,100	48,350	48,600	48,850	49,090	49,330	49,570	49,810	35
36	45,910	46,180	46,460	46,730	47,010	47,280	47,550	47,820	48,090	48,350	48,620	48,890	49,150	49,410	49,670	49,930	50,180	50,440	50,690	50,930	51,180	36
37	47,250	47,530	47,810	48,100	48,380	48,660	48,930	49,210	49,480	49,760	50,030	50,300	50,570	50,840	51,110	51,370	51,630	51,890	52,150	52,400	52,660	37
38	48,460	48,750	49,040	49,330	49,620	49,910	50,190	50,480	50,760	51,040	51,320	51,600	51,880	52,160	52,430	52,710	52,970	53,240	53,500	53,760	54,030	38
39	49,800	50,100	50,400	50,690	50,990	51,280	51,570	51,870	52,160	52,440	52,730	53,020	53,300	53,590	53,870	54,150	54,420	54,690	54,960	55,230	55,500	39
40	51,010	51,310	51,620	51,930	52,230	52,530	52,830	53,130	53,430	53,730	54,020	54,320	54,610	54,900	55,190	55,480	55,760	56,040	56,320	56,590	56,870	40
41	52,350	52,660	52,980	53,290	53,600	53,910	54,220	54,520	54,830	55,130	55,430	55,730	56,030	56,330	56,630	56,920	57,210	57,490	57,780	58,060	58,340	41
42	53,560	53,880	54,200	54,520	54,840	55,160	55,470	55,790	56,100	56,410	56,720	57,030	57,340	57,650	57,950	58,250	58,550	58,840	59,130	59,420	59,710	42
43	54,900	55,230	55,560	55,890	56,210	56,530	56,860	57,180	57,500	57,820	58,130	58,450	58,760	59,080	59,390	59,700	60,000	60,300	60,590	60,890	61,190	43
44	56,110	56,450	56,780	57,120	57,450	57,790	58,120	58,450	58,770	59,100	59,430	59,750	60,070	60,390	60,710	61,030	61,340	61,640	61,950	62,250	62,560	44
45	57,450	57,800	58,140	58,480	58,820	59,160	59,500	59,840	60,170	60,500	60,840	61,170	61,490	61,820	62,150	62,470	62,790	63,100	63,410	63,720	64,030	45
46	58,660	59,010	59,360	59,720	60,060	60,410	60,760	61,100	61,450	61,790	62,130	62,470	62,800	63,140	63,470	63,800	64,130	64,450	64,770	65,080	65,400	46
47	60,000	60,360	60,720	61,080	61,430	61,790	62,140	62,490	62,840	63,190	63,540	63,880	64,230	64,570	64,910	65,250	65,570	65,900	66,230	66,550	66,870	47
48	61,210	61,580	61,950	62,310	62,680	63,040	63,400	63,760	64,120	64,470	64,830	65,180	65,530	65,880	66,230	66,580	66,910	67,250	67,580	67,910	68,240	48
49	62,550	62,930	63,300	63,670	64,050	64,410	64,780	65,150	65,510	65,880	66,240	66,600	66,960	67,310	67,670	68,020	68,360	68,700	69,040	69,380	69,720	49
50	63,760	64,140	64,530	64,910	65,290	65,660	66,040	66,420	66,790	67,160	67,530	67,900	68,260	68,630	68,990	69,350	69,700	70,050	70,400	70,740	71,090	50
51	65,100	65,490	65,880	66,270	66,660	67,040	67,420	67,810	68,180	68,560	68,940	69,310	69,690	70,060	70,430	70,790	71,150	71,500	71,860	72,210	72,560	51
52	66,310	66,710	67,110	67,500	67,900	68,290	68,680	69,070	69,460	69,850	70,230	70,610	70,990	71,370	71,750	72,130	72,490	72,850	73,210	73,570	73,930	52
53	67,650	68,060	68,460	68,870	69,270	69,670	70,070	70,460	70,860	71,250	71,640	72,030	72,420	72,800	73,190	73,570	73,940	74,310	74,670	75,040	75,400	53
54	68,860	69,270	69,690	70,100	70,510	70,920	71,320	71,730	72,130	72,530	72,930	73,330	73,720	74,120	74,510	74,900	75,280	75,650	76,030	76,400	76,770	54
55	70,200	70,620	71,040	71,460	71,880	72,290	72,710	73,120	73,530	73,940	74,340	74,740	75,150	75,550	75,950	76,340	76,730	77,110	77,490	77,870	78,250	55
56	71,410	71,840	72,270	72,700	73,120	73,540	73,970	74,390	74,800	75,220	75,630	76,040	76,460	76,860	77,270	77,670	78,070	78,460	78,840	79,230	79,620	56
57	72,750	73,190	73,630	74,060	74,490	74,920	75,350	75,780	76,200	76,620	77,040	77,460	77,880	78,290	78,710	79,120	79,510	79,910	80,310	80,700	81,090	57
58	73,960	74,410	74,850	75,290	75,730	76,170	76,610	77,040	77,470	77,900	78,330	78,760	79,190	79,610	80,030	80,450	80,850	81,260	81,660	82,060	82,460	58
59	75,300	75,760	76,210	76,660	77,100	77,550	77,990	78,430	78,870	79,310	79,740	80,180	80,610	81,040	81,470	81,890	82,300	82,710	83,120	83,530	83,930	59
60	76,510	76,970	77,430	77,890	78,340	78,800	79,250	79,700	80,150	80,590	81,030	81,480	81,920	82,350	82,790	83,220	83,640	84,060	84,480	84,890	85,300	60

WHEELER DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	552.0	552.1	552.2	552.3	552.4	552.5	552.6	552.7	552.8	552.9	553.0	553.1	553.2	553.3	553.4	553.5	553.6	553.7	553.8	553.9	554.0	
61	80,050	80,530	81,010	81,480	81,950	82,420	82,890	83,360	83,820	84,280	84,740	85,200	85,660	86,110	86,560	87,010	87,450	87,880	88,310	88,740	89,170	61
62	83,220	83,720	84,210	84,700	85,190	85,680	86,160	86,650	87,130	87,610	88,080	88,560	89,030	89,500	89,970	90,430	90,880	91,330	91,780	92,230	92,670	62
63	86,350	86,870	87,380	87,900	88,400	88,910	89,420	89,920	90,420	90,910	91,410	91,900	92,390	92,880	93,370	93,850	94,320	94,790	95,260	95,720	96,190	63
64	89,260	89,800	90,340	90,870	91,400	91,930	92,460	92,980	93,500	94,020	94,540	95,060	95,570	96,080	96,590	97,090	97,580	98,070	98,560	99,040	99,520	64
65	92,800	93,360	93,910	94,460	95,010	95,560	96,100	96,640	97,180	97,720	98,250	98,780	99,310	99,840	100,400	100,900	101,400	101,900	102,400	102,900	103,400	65
66	95,970	96,550	97,120	97,680	98,250	98,810	99,370	99,930	100,500	101,000	101,600	102,100	102,700	103,200	103,800	104,300	104,800	105,300	105,900	106,400	106,900	66
67	99,110	99,700	100,300	100,900	101,500	102,000	102,600	103,200	103,800	104,300	104,900	105,500	106,000	106,600	107,200	107,700	108,300	108,800	109,300	109,900	110,400	67
68	102,000	102,600	103,200	103,900	104,500	105,100	105,700	106,300	106,900	107,500	108,000	108,600	109,200	109,800	110,400	111,000	111,500	112,100	112,600	113,200	113,700	68
69	105,600	106,200	106,800	107,400	108,100	108,700	109,300	109,900	110,500	111,100	111,800	112,400	113,000	113,600	114,200	114,800	115,300	115,900	116,500	117,000	117,600	69
70	108,700	109,400	110,000	110,700	111,300	111,900	112,600	113,200	113,800	114,500	115,100	115,700	116,300	117,000	117,600	118,200	118,800	119,400	119,900	120,500	121,100	70
71	111,900	112,500	113,200	113,900	114,500	115,200	115,800	116,500	117,100	117,800	118,400	119,100	119,700	120,300	121,000	121,600	122,200	122,800	123,400	124,000	124,600	71
72	114,800	115,500	116,100	116,800	117,500	118,200	118,900	119,500	120,200	120,900	121,600	122,200	122,900	123,500	124,200	124,800	125,500	126,100	126,700	127,300	128,000	72
73	118,300	119,000	119,700	120,400	121,100	121,800	122,500	123,200	123,900	124,600	125,300	125,900	126,600	127,300	128,000	128,600	129,300	129,900	130,600	131,200	131,800	73
74	121,500	122,200	122,900	123,600	124,400	125,100	125,800	126,500	127,200	127,900	128,600	129,300	130,000	130,700	131,400	132,000	132,700	133,400	134,000	134,700	135,300	74
75	124,600	125,400	126,100	126,800	127,600	128,300	129,000	129,800	130,500	131,200	131,900	132,600	133,400	134,100	134,800	135,500	136,100	136,800	137,500	138,200	138,800	75
76	127,500	128,300	129,100	129,800	130,600	131,300	132,100	132,800	133,600	134,300	135,100	135,800	136,500	137,300	138,000	138,700	139,400	140,100	140,800	141,500	142,200	76
77	131,100	131,800	132,600	133,400	134,200	135,000	135,700	136,500	137,300	138,000	138,800	139,500	140,300	141,000	141,800	142,500	143,200	143,900	144,600	145,300	146,000	77
78	134,200	135,000	135,800	136,600	137,400	138,200	139,000	139,800	140,600	141,300	142,100	142,900	143,600	144,400	145,200	145,900	146,600	147,400	148,100	148,800	149,500	78
79	137,400	138,200	139,000	139,800	140,600	141,400	142,200	143,000	143,800	144,600	145,400	146,200	147,000	147,800	148,600	149,300	150,100	150,800	151,600	152,300	153,100	79
80	140,300	141,100	142,000	142,800	143,600	144,500	145,300	146,100	146,900	147,800	148,600	149,400	150,200	151,000	151,800	152,600	153,300	154,100	154,900	155,600	156,400	80
81	143,800	144,700	145,500	146,400	147,200	148,100	148,900	149,800	150,600	151,400	152,300	153,100	153,900	154,700	155,600	156,400	157,100	157,900	158,700	159,500	160,300	81
82	147,000	147,900	148,700	149,600	150,500	151,300	152,200	153,100	153,900	154,800	155,600	156,500	157,300	158,100	159,000	159,800	160,600	161,400	162,200	163,000	163,800	82
83	150,100	151,000	151,900	152,800	153,700	154,600	155,500	156,300	157,200	158,100	158,900	159,800	160,700	161,500	162,400	163,200	164,000	164,800	165,700	166,500	167,300	83
84	153,000	153,900	154,900	155,800	156,700	157,600	158,500	159,400	160,300	161,200	162,100	163,000	163,800	164,700	165,600	166,400	167,300	168,100	169,000	169,800	170,600	84
85	161,100	162,000	163,000	163,900	164,900	165,900	166,800	167,800	168,700	169,600	170,600	171,500	172,400	173,400	174,300	175,200	176,100	177,000	177,900	178,800	179,700	85
86	169,100	170,100	171,100	172,100	173,100	174,100	175,100	176,100	177,100	178,100	179,100	180,100	181,100	182,100	183,000	184,000	185,000	185,900	186,900	187,800	188,800	86
87	177,100	178,200	179,200	180,200	181,300	182,400	183,400	184,500	185,500	186,600	187,600	188,700	189,700	190,700	191,800	192,800	193,800	194,800	195,900	196,900	197,900	87
88	185,200	186,200	187,300	188,400	189,500	190,600	191,700	192,800	194,000	195,000	196,100	197,200	198,300	199,400	200,500	201,600	202,700	203,700	204,800	205,900	206,900	88
89	193,200	194,300	195,400	196,500	197,700	198,900	200,100	201,200	202,400	203,500	204,700	205,800	206,900	208,100	209,200	210,400	211,500	212,700	213,800	214,900	216,000	89
90	201,300	202,400	203,500	204,700	205,900	207,100	208,400	209,600	210,800	212,000	213,200	214,400	215,500	216,700	218,000	219,200	220,400	221,600	222,700	223,900	225,100	90
91	209,300	210,400	211,600	212,800	214,100	215,400	216,700	217,900	219,200	220,400	221,700	222,900	224,100	225,400	226,700	228,000	229,200	230,500	231,700	233,000	234,200	91
92	217,400	218,500	219,700	221,000	222,300	223,700	225,000	226,300	227,600	228,900	230,200	231,500	232,800	234,100	235,400	236,800	238,100	239,400	240,700	242,000	243,300	92
93	225,400	226,600	227,800	229,100	230,500	231,900	233,300	234,700	236,000	237,400	238,700	240,100	241,400	242,800	244,200	245,500	246,900	248,300	249,600	251,000	252,300	93
94	233,400	234,700	235,900	237,300	238,700	240,200	241,600	243,000	244,400	245,800	247,200	248,600	250,000	251,400	252,900	254,300	255,800	257,200	258,600	260,000	261,400	94
95	241,500	242,700	244,000	245,400	246,900	248,400	249,900	251,400	252,900	254,300	255,800	257,200	258,600	260,100	261,600	263,100	264,600	266,100	267,600	269,000	270,500	95
96	249,500	250,800	252,100	253,600	255,100	256,700	258,200	259,800	261,300	262,800	264,300	265,800	267,200	268,800	270,400	271,900	273,500	275,000	276,500	278,100	279,600	96
97	254,400	256,000	257,600	259,300	261,200	263,000	264,800	266,600	268,400	270,200	272,000	273,800	275,600	277,400	279,300	281,100	283,000	284,800	286,700	288,500	290,300	97
98	259,300	261,200	263,000	265,100	267,200	269,300	271,400	273,500	275,600	277,700	279,800	281,800	283,900	286,000	288,200	290,400	292,500	294,700	296,800	299,000	300,900	98
99	264,200	266,400	268,500	270,900	273,200	275,600	278,000	280,400	282,800	285,100	287,500	289,900	292,200	294,700	297,100	299,600	302,100	304,500	307,000	309,400	311,600	99
100	269,200	271,600	274,000	276,600	279,300	281,900	284,600	287,300	289,900	292,600	295,200	297,900	300,600	303,300	306,100	308,800	311,600	314,400	317,100	319,900	322,300	100
101	274,100	276,800	279,500	282,400	285,300	288,200	291,200	294,100	297,100	300,000	303,000	305,900	308,900	311,900	315,000	318,100	321,100	324,200	327,300	330,400	333,000	101
102	279,000	282,000	285,000	288,200	291,400	294,600	297,800	301,000	304,200	307,500	310,700	314,000	317,300	320,600	323,900	327,300	330,700	334,000	337,400	340,800	343,600	102
103	283,900	287,200	290,500	293,900	297,400	300,900	304,400	307,900	311,400	314,900	318,500	322,000	325,600	329,200	332,900	336,500	340,200	343,900	347,600	351,300	354,300	103
104	288,800	292,400	296,000	299,700	303,400	307,200	311,000	314,700	318,600	322,400	326,200	330,100	333,900	337,800	341,800	345,700	349,700	353,700	357,700	361,700	365,000	104
105	293,700	297,600	301,500	305,400	309,500	313,500	317,500	321,600	325,700	329,800	334,000	338,100	342,300	346,500	350,700	355,000	359,200	363,500	367,900	372,200	375,600	105
106	298,600	302,800	307,000	311,200	315,500	319,800	324,100	328,500	332,900	337,300	341,700	346,100	350,600	355,100	359,600	364,200	368,800	373,400	378,000	382,600	386,300	106
107	303,500	308,000	312,400	317,000	321,500	326,100	330,700	335,400	340,000	344,700	349,400	354,200	358,900	363,700	368,600	373,400	378,300	383,200	388,100	393,100	397,000	107
108	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	407,700	108
109	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	407,800	109
110	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	407,900	110
111	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	408,000	111
112	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	408,100	112
113	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	408,200	113
114	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	408,300	114
115	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	408,400	115
116	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	408,500	116
117	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	408,600	117
118	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	408,700	118
119	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	408,800	119
120	308,400	313,200	317,900	322,700	327,600	332,400	337,300	342,200	347,200	352,200	357,200	362,200	367,300	372,400	377,500	382,700	387,800	393,000	398,300	403,600	408,800	120

WHEELER DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	554.0	554.1	554.2	554.3	554.4	554.5	554.6	554.7	554.8	554.9	555.0	555.1	555.2	555.3	555.4	555.5	555.6	555.7	555.8	555.9	556.0	
1	1,470	1,480	1,490	1,490	1,500	1,510	1,510	1,520	1,520	1,530	1,540	1,540	1,550	1,550	1,560	1,570	1,570	1,580	1,580	1,590	1,600	1
2	2,840	2,860	2,870	2,880	2,900	2,910	2,920	2,940	2,950	2,960	2,980	2,990	3,000	3,020	3,030	3,040	3,060	3,070	3,080	3,100	3,110	2
3	4,320	4,340	4,360	4,380	4,400	4,420	4,440	4,460	4,480	4,500	4,510	4,530	4,550	4,570	4,590	4,610	4,630	4,650	4,670	4,690	4,700	3
4	5,690	5,710	5,740	5,770	5,800	5,820	5,850	5,880	5,900	5,930	5,960	5,980	6,010	6,040	6,060	6,090	6,110	6,140	6,160	6,190	6,220	4
5	7,160	7,190	7,230	7,260	7,300	7,330	7,360	7,390	7,430	7,460	7,490	7,530	7,560	7,590	7,620	7,650	7,690	7,720	7,750	7,780	7,810	5
6	8,530	8,570	8,610	8,650	8,690	8,730	8,770	8,810	8,850	8,890	8,930	8,970	9,010	9,050	9,090	9,130	9,170	9,210	9,250	9,290	9,320	6
7	10,000	10,050	10,100	10,150	10,190	10,240	10,290	10,330	10,380	10,420	10,470	10,520	10,560	10,610	10,650	10,700	10,740	10,790	10,830	10,880	10,920	7
8	11,370	11,430	11,480	11,540	11,590	11,650	11,700	11,750	11,810	11,860	11,910	11,970	12,020	12,070	12,120	12,170	12,230	12,280	12,330	12,380	12,430	8
9	12,850	12,910	12,970	13,030	13,090	13,150	13,210	13,270	13,330	13,390	13,450	13,510	13,570	13,620	13,680	13,740	13,800	13,860	13,910	13,970	14,030	9
10	14,220	14,290	14,350	14,420	14,490	14,560	14,620	14,690	14,760	14,820	14,890	14,960	15,020	15,090	15,150	15,220	15,280	15,350	15,410	15,480	15,540	10
11	15,690	15,770	15,840	15,920	15,990	16,060	16,140	16,210	16,280	16,350	16,430	16,500	16,570	16,640	16,710	16,780	16,860	16,930	17,000	17,070	17,140	11
12	17,060	17,140	17,230	17,310	17,390	17,470	17,550	17,630	17,710	17,790	17,870	17,950	18,030	18,110	18,180	18,260	18,340	18,420	18,490	18,570	18,650	12
13	18,530	18,620	18,710	18,800	18,890	18,970	19,060	19,150	19,230	19,320	19,410	19,490	19,580	19,660	19,740	19,830	19,910	20,000	20,080	20,160	20,240	13
14	19,900	20,000	20,100	20,190	20,290	20,380	20,470	20,570	20,660	20,750	20,850	20,940	21,030	21,120	21,210	21,310	21,400	21,490	21,580	21,670	21,760	14
15	21,380	21,480	21,580	21,680	21,790	21,890	21,990	22,090	22,190	22,280	22,380	22,480	22,580	22,680	22,770	22,870	22,970	23,060	23,160	23,260	23,350	15
16	22,750	22,860	22,970	23,080	23,180	23,290	23,400	23,510	23,610	23,720	23,830	23,930	24,040	24,140	24,240	24,350	24,450	24,560	24,660	24,760	24,860	16
17	24,220	24,340	24,450	24,570	24,680	24,800	24,910	25,020	25,140	25,250	25,360	25,470	25,580	25,700	25,810	25,920	26,030	26,130	26,240	26,350	26,460	17
18	25,590	25,710	25,840	25,960	26,080	26,200	26,320	26,440	26,560	26,680	26,800	26,920	27,040	27,160	27,280	27,390	27,510	27,630	27,740	27,860	27,970	18
19	27,070	27,190	27,320	27,450	27,580	27,710	27,840	27,960	28,090	28,210	28,340	28,460	28,590	28,710	28,840	28,960	29,080	29,200	29,330	29,450	29,570	19
20	28,430	28,570	28,710	28,840	28,980	29,110	29,250	29,380	29,520	29,650	29,780	29,910	30,040	30,180	30,310	30,440	30,570	30,690	30,820	30,950	31,080	20
21	29,910	30,050	30,200	30,340	30,480	30,620	30,760	30,900	31,040	31,180	31,320	31,460	31,590	31,730	31,870	32,000	32,140	32,270	32,410	32,540	32,680	21
22	31,280	31,430	31,580	31,730	31,880	32,030	32,170	32,320	32,470	32,610	32,760	32,900	33,050	33,190	33,340	33,480	33,620	33,760	33,910	34,050	34,190	22
23	32,750	32,910	33,070	33,220	33,380	33,530	33,690	33,840	33,990	34,140	34,300	34,450	34,600	34,750	34,900	35,050	35,190	35,340	35,490	35,640	35,780	23
24	34,120	34,290	34,450	34,610	34,780	34,940	35,100	35,260	35,420	35,580	35,740	35,900	36,050	36,210	36,370	36,520	36,680	36,830	36,990	37,140	37,290	24
25	35,600	35,770	35,940	36,110	36,280	36,440	36,610	36,780	36,940	37,110	37,270	37,440	37,600	37,770	37,930	38,090	38,250	38,410	38,570	38,730	38,890	25
26	36,970	37,140	37,320	37,500	37,670	37,850	38,020	38,200	38,370	38,540	38,720	38,890	39,060	39,230	39,400	39,570	39,740	39,900	40,070	40,240	40,400	26
27	38,440	38,620	38,810	38,990	39,170	39,350	39,540	39,720	39,900	40,070	40,250	40,430	40,610	40,780	40,960	41,130	41,310	41,480	41,650	41,830	42,000	27
28	39,810	40,000	40,190	40,380	40,570	40,760	40,950	41,140	41,320	41,510	41,690	41,880	42,060	42,250	42,430	42,610	42,790	42,970	43,150	43,330	43,510	28
29	41,280	41,480	41,680	41,880	42,070	42,270	42,460	42,650	42,850	43,040	43,230	43,420	43,610	43,800	43,990	44,180	44,360	44,550	44,740	44,920	45,110	29
30	42,650	42,860	43,060	43,270	43,470	43,670	43,870	44,070	44,270	44,470	44,670	44,870	45,070	45,260	45,460	45,650	45,850	46,040	46,230	46,430	46,620	30
31	44,130	44,340	44,550	44,760	44,970	45,180	45,390	45,590	45,800	46,000	46,210	46,410	46,620	46,820	47,020	47,220	47,420	47,620	47,820	48,020	48,210	31
32	45,500	45,720	45,930	46,150	46,370	46,580	46,800	47,010	47,230	47,440	47,650	47,860	48,070	48,280	48,490	48,700	48,900	49,110	49,320	49,520	49,730	32
33	46,970	47,200	47,420	47,640	47,870	48,090	48,310	48,530	48,750	48,970	49,190	49,400	49,620	49,840	50,050	50,260	50,480	50,690	50,900	51,110	51,320	33
34	48,340	48,570	48,800	49,040	49,270	49,500	49,720	49,950	50,180	50,400	50,630	50,850	51,080	51,300	51,520	51,740	51,960	52,180	52,400	52,620	52,830	34
35	49,810	50,050	50,290	50,530	50,770	51,000	51,240	51,470	51,700	51,930	52,170	52,400	52,620	52,850	53,080	53,310	53,530	53,760	53,980	54,210	54,430	35
36	51,180	51,430	51,680	51,920	52,160	52,410	52,650	52,890	53,130	53,370	53,610	53,840	54,080	54,320	54,550	54,790	55,020	55,250	55,480	55,710	55,940	36
37	52,660	52,910	53,160	53,410	53,660	53,910	54,160	54,410	54,650	54,900	55,140	55,390	55,630	55,870	56,110	56,350	56,590	56,830	57,070	57,300	57,540	37
38	54,030	54,290	54,550	54,800	55,060	55,320	55,570	55,830	56,080	56,330	56,590	56,840	57,090	57,330	57,580	57,830	58,070	58,320	58,560	58,810	59,050	38
39	55,500	55,770	56,030	56,300	56,560	56,820	57,090	57,350	57,610	57,860	58,120	58,380	58,630	58,890	59,140	59,400	59,650	59,900	60,150	60,400	60,650	39
40	56,870	57,140	57,420	57,690	57,960	58,230	58,500	58,770	59,030	59,300	59,560	59,830	60,090	60,350	60,610	60,870	61,130	61,390	61,650	61,900	62,160	40
41	58,340	58,620	58,900	59,180	59,460	59,740	60,010	60,280	60,560	60,830	61,100	61,370	61,640	61,910	62,170	62,440	62,700	62,970	63,230	63,490	63,750	41
42	59,710	60,000	60,290	60,570	60,860	61,140	61,420	61,700	61,980	62,260	62,540	62,820	63,090	63,370	63,640	63,920	64,190	64,460	64,730	65,000	65,270	42
43	61,190	61,480	61,770	62,070	62,360	62,650	62,940	63,220	63,510	63,790	64,080	64,360	64,640	64,920	65,200	65,480	65,760	66,040	66,310	66,590	66,860	43
44	62,560	62,860	63,160	63,460	63,760	64,050	64,350	64,640	64,940	65,230	65,520	65,810	66,100	66,390	66,670	66,960	67,240	67,530	67,810	68,090	68,370	44
45	64,030	64,340	64,650	64,950	65,260	65,560	65,860	66,160	66,460	66,760	67,060	67,350	67,650	67,940	68,230	68,530	68,820	69,110	69,400	69,680	69,970	45
46	65,400	65,720	66,030	66,340	66,650	66,960	67,270	67,580	67,890	68,190	68,500	68,800	69,100	69,400	69,700	70,000	70,300	70,600	70,890	71,190	71,480	46
47	66,870	67,200	67,520	67,840	68,150	68,470	68,790	69,100	69,410	69,720	70,030	70,340	70,650	70,960	71,260	71,570	71,870	72,180	72,480	72,780	73,080	47
48	68,240	68,570	68,900	69,230	69,550	69,880	70,200	70,520	70,840	71,160	71,480	71,790	72,110	72,420	72,730	73,050	73,360	73,670	73,980	74,280	74,590	48
49	69,720	70,050	70,390	70,720	71,050	71,380	71,710	72,040	72,360	72,690	73,010	73,330	73,660	73,980	74,300	74,610	74,930	75,250	75,560	75,870	76,190	49
50	71,090	71,430	71,770	72,110	72,450	72,790	73,120	73,460	73,790	74,120	74,450	74,780	75,110	75,440	75,770	76,090	76,410	76,740	77,060	77,380	77,700	50
51	72,560	72,910	73,260	73,600	73,950	74,290	74,630	74,980	75,320	75,650	75,990	76,330	76,660	76,990	77,330	77,660	77,990	78,320	78,640	78,970	79,290	51
52	73,930	74,290	74,640	75,000	75,350	75,700	76,050	76,400	76,740	77,090	77,430	77,780	78,120	78,460	78,800	79,130	79,470	79,810	80,140	80,470	80,810	52
53	75,400	75,770	76,130	76,490	76,850	77,200	77,560	77,910	78,270	78,620	78,970	79,320	79,670	80,010	80,360	80,700	81,040	81,380	81,720	82,060	82,400	53
54	76,770	77,140	77,510	77,880	78,250	78,610	78,970	79,330	79,690	80,050	80,410	80,770	81,120	81,470	81,830	82,180	82,530	82,880	83,220	83,570	83,910	54
55	78,250	78,620	79,000	79,370	79,750	80,120	80,480	80,850	81,220	81,580	81,950	82,310	82,670	83,030	83,390	83,740	84,100	84,450	84,810	85,160	85,510	55
56	79,620	80,000	80,380	80,760	81,140	81,520	81,900	82,270	82,650	83,020	83,390	83,760	84,130	84,490	84,860	85,220	85,580	85,940	86,300	86,660	87,020	56
57	81,090	81,480	81,870	82,260	82,640	83,030	83,410	83,790	84,170	84,550	84,930	85,300	85,670	86,050	86,420	86,790	87,160	87,520	87,890	88,250	88,620	57
58	82,460	82,860	83,250	83,650	84,040	84,430	84,820	85,210	85,600	85,980	86,370	86,750	87,130	87,510	87,890	88,260	88,640	89,010	89,390	89,760	90,130	58
59	83,930	84,340	84,740	85,140	85,540	85,940	86,330	86,730	87,120	87,510	87,900	88,290	88,680	89,060	89,450	89,830	90,210	90,590	90,970	91,350	91,730	59
60	85,300	85,720	86,130	86,530	86,940	87,340	87,750	88,150	88,550	88,950	89,350	89,740	90,130	90,530	90,920	91,310	91,700	92,080	92,470	92,850	93,240	60

WHEELER DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	554.0	554.1	554.2	554.3	554.4	554.5	554.6	554.7	554.8	554.9	555.0	555.1	555.2	555.3	555.4	555.5	555.6	555.7	555.8	555.9	556.0	
61	89,170	89,600	90,020	90,450	90,870	91,290	91,710	92,130	92,540	92,950	93,370	93,780	94,190	94,590	95,000	95,400	95,810	96,210	96,610	97,010	97,400	61
62	92,670	93,120	93,560	94,000	94,440	94,870	95,310	95,740	96,170	96,600	97,030	97,450	97,880	98,300	98,720	99,140	99,560	99,980	100,400	100,800	101,200	62
63	96,190	96,650	97,110	97,560	98,020	98,470	98,920	99,370	99,820	100,300	100,700	101,200	101,600	102,000	102,500	102,900	103,300	103,800	104,200	104,600	105,100	63
64	99,520	100,000	100,500	101,000	101,400	101,900	102,400	102,800	103,300	103,800	104,200	104,700	105,200	105,600	106,100	106,500	107,000	107,400	107,900	108,300	108,800	64
65	103,400	103,900	104,400	104,900	105,400	105,800	106,300	106,800	107,300	107,800	108,300	108,700	109,200	109,700	110,200	110,600	111,100	111,600	112,000	112,500	112,900	65
66	106,900	107,400	107,900	108,400	108,900	109,400	109,900	110,400	110,900	111,400	111,900	112,400	112,900	113,400	113,900	114,400	114,800	115,300	115,800	116,300	116,800	66
67	110,400	110,900	111,500	112,000	112,500	113,000	113,500	114,100	114,600	115,100	115,600	116,100	116,600	117,100	117,600	118,100	118,600	119,100	119,600	120,100	120,600	67
68	113,700	114,300	114,800	115,400	115,900	116,500	117,000	117,500	118,100	118,600	119,100	119,700	120,200	120,700	121,200	121,700	122,300	122,800	123,300	123,800	124,300	68
69	117,600	118,200	118,700	119,300	119,800	120,400	121,000	121,500	122,100	122,600	123,100	123,700	124,200	124,800	125,300	125,800	126,400	126,900	127,400	128,000	128,500	69
70	121,100	121,700	122,300	122,800	123,400	124,000	124,600	125,100	125,700	126,200	126,800	127,400	127,900	128,500	129,000	129,600	130,100	130,700	131,200	131,800	132,300	70
71	124,600	125,200	125,800	126,400	127,000	127,600	128,200	128,800	129,300	129,900	130,500	131,100	131,600	132,200	132,800	133,300	133,900	134,500	135,000	135,600	136,100	71
72	128,000	128,600	129,200	129,800	130,400	131,000	131,600	132,200	132,800	133,400	134,000	134,600	135,200	135,800	136,400	137,000	137,500	138,100	138,700	139,300	139,900	72
73	131,800	132,500	133,100	133,700	134,300	135,000	135,600	136,200	136,800	137,400	138,000	138,600	139,300	139,900	140,500	141,100	141,700	142,200	142,800	143,400	144,000	73
74	135,300	136,000	136,600	137,300	137,900	138,500	139,200	139,800	140,400	141,100	141,700	142,300	142,900	143,600	144,200	144,800	145,400	146,000	146,600	147,200	147,800	74
75	138,800	139,500	140,200	140,800	141,500	142,100	142,800	143,400	144,100	144,700	145,400	146,000	146,700	147,300	147,900	148,600	149,200	149,800	150,400	151,100	151,700	75
76	142,200	142,900	143,500	144,200	144,900	145,600	146,200	146,900	147,600	148,200	148,900	149,600	150,200	150,900	151,500	152,200	152,800	153,500	154,100	154,800	155,400	76
77	146,000	146,700	147,400	148,100	148,800	149,500	150,200	150,900	151,600	152,300	152,900	153,600	154,300	154,900	155,600	156,300	156,900	157,600	158,300	158,900	159,600	77
78	149,500	150,300	151,000	151,700	152,400	153,100	153,800	154,500	155,200	155,900	156,600	157,300	158,000	158,700	159,300	160,000	160,700	161,400	162,000	162,700	163,400	78
79	153,100	153,800	154,500	155,300	156,000	156,700	157,400	158,100	158,900	159,600	160,300	161,000	161,700	162,400	163,100	163,800	164,500	165,200	165,900	166,500	167,200	79
80	156,400	157,100	157,900	158,600	159,400	160,100	160,900	161,600	162,300	163,100	163,800	164,500	165,200	166,000	166,700	167,400	168,100	168,800	169,500	170,200	170,900	80
81	160,300	161,000	161,800	162,600	163,300	164,100	164,800	165,600	166,300	167,100	167,800	168,600	169,300	170,000	170,800	171,500	172,200	172,900	173,700	174,400	175,100	81
82	163,800	164,500	165,300	166,100	166,900	167,700	168,400	169,200	170,000	170,700	171,500	172,200	173,000	173,700	174,500	175,200	176,000	176,700	177,400	178,200	178,900	82
83	167,300	168,100	168,900	169,700	170,500	171,300	172,000	172,800	173,600	174,400	175,200	175,900	176,700	177,500	178,200	179,000	179,800	180,500	181,300	182,000	182,800	83
84	170,600	171,400	172,300	173,100	173,900	174,700	175,500	176,300	177,100	177,900	178,700	179,500	180,300	181,100	181,800	182,600	183,400	184,200	184,900	185,700	186,500	84
85	179,700	180,600	181,400	182,300	183,200	184,100	184,900	185,800	186,700	187,500	188,400	189,200	190,100	190,900	191,700	192,600	193,400	194,200	195,100	195,900	196,700	85
86	188,800	189,700	190,600	191,600	192,500	193,400	194,400	195,300	196,200	197,100	198,000	198,900	199,900	200,800	201,700	202,500	203,400	204,300	205,200	206,100	207,000	86
87	197,900	198,800	199,800	200,800	201,800	202,800	203,800	204,800	205,800	206,700	207,700	208,700	209,600	210,600	211,600	212,500	213,500	214,400	215,400	216,300	217,200	87
88	206,900	208,000	209,000	210,100	211,100	212,200	213,200	214,300	215,300	216,400	217,400	218,400	219,400	220,500	221,500	222,500	223,500	224,500	225,500	226,500	227,500	88
89	216,000	217,100	218,200	219,300	220,500	221,600	222,700	223,800	224,900	226,000	227,100	228,200	229,200	230,300	231,400	232,400	233,500	234,600	235,600	236,700	237,700	89
90	225,100	226,300	227,400	228,600	229,800	231,000	232,100	233,300	234,400	235,600	236,700	237,900	239,000	240,200	241,300	242,400	243,500	244,700	245,800	246,900	248,000	90
91	234,200	235,400	236,600	237,900	239,100	240,300	241,600	242,800	244,000	245,200	246,400	247,600	248,800	250,000	251,200	252,400	253,600	254,700	255,900	257,100	258,200	91
92	243,300	244,500	245,800	247,100	248,400	249,700	251,000	252,300	253,600	254,800	256,100	257,400	258,600	259,900	261,100	262,300	263,600	264,800	266,000	267,300	268,500	92
93	252,300	253,700	255,000	256,400	257,700	259,100	260,400	261,800	263,100	264,400	265,800	267,100	268,400	269,700	271,000	272,300	273,600	274,900	276,200	277,500	278,700	93
94	261,400	262,800	264,200	265,600	267,100	268,500	269,900	271,300	272,700	274,100	275,400	276,800	278,200	279,600	280,900	282,300	283,600	285,000	286,300	287,600	289,000	94
95	270,500	272,000	273,400	274,900	276,400	277,800	279,300	280,800	282,200	283,700	285,100	286,600	288,000	289,400	290,800	292,200	293,700	295,100	296,400	297,800	299,200	95
96	279,600	281,100	282,600	284,100	285,700	287,200	288,700	290,300	291,800	293,300	294,800	296,300	297,800	299,300	300,700	302,200	303,700	305,100	306,600	308,000	309,500	96
97	290,300	291,700	293,100	294,500	296,000	297,500	298,900	300,400	301,800	303,200	304,600	306,100	307,600	309,000	310,500	311,900	313,400	314,800	316,200	317,600	319,000	97
98	300,900	302,300	303,600	305,000	306,300	307,700	309,100	310,400	311,800	313,100	314,500	315,900	317,400	318,800	320,200	321,600	323,000	324,400	325,800	327,200	328,600	98
99	311,600	312,800	314,100	315,400	316,700	317,900	319,200	320,500	321,800	323,000	324,300	325,700	327,200	328,600	330,000	331,300	332,700	334,100	335,400	336,800	338,100	99
100	322,300	323,400	324,600	325,800	327,000	328,200	329,400	330,600	331,800	332,900	334,200	335,600	337,000	338,300	339,700	341,000	342,400	343,700	345,000	346,300	347,700	100
101	333,000	334,000	335,100	336,200	337,300	338,400	339,600	340,700	341,800	342,900	344,000	345,400	346,700	348,100	349,400	350,800	352,100	353,400	354,600	355,900	357,300	101
102	343,600	344,600	345,500	346,600	347,600	348,700	349,700	350,800	351,800	352,800	353,800	355,200	356,500	357,900	359,200	360,500	361,700	363,000	364,200	365,500	366,800	102
103	354,300	355,200	356,000	357,000	358,000	358,900	359,900	360,800	361,800	362,700	363,700	365,000	366,300	367,600	368,900	370,200	371,400	372,600	373,900	375,000	376,400	103
104	365,000	365,700	366,500	367,400	368,300	369,100	370,000	370,900	371,800	372,600	373,500	374,800	376,100	377,400	378,600	379,900	381,100	382,300	383,500	384,600	385,900	104
105	375,600	376,300	377,000	377,800	378,600	379,400	380,200	381,000	381,800	382,500	383,400	384,700	385,900	387,200	388,400	389,600	390,800	391,900	393,100	394,200	395,500	105
106	386,300	386,900	387,500	388,200	388,900	389,600	390,400	391,100	391,800	392,400	393,200	394,500	395,700	396,900	398,100	399,300	400,400	401,600	402,700	403,800	405,000	106
107	397,000	397,500	398,000	398,600	399,200	399,900	400,500	401,200	401,800	402,300	403,100	404,300	405,500	406,700	407,900	409,000	410,100	411,200	412,300	413,300	414,600	107
108	407,700	408,100	408,500	409,000	409,600	410,100	410,700	411,300	411,800	412,300	412,900	414,100	415,300	416,500	417,600	418,700	419,800	420,900	421,900	422,900	424,200	108
109	407,800	408,600	409,400	410,400	411,300	412,200	413,200	414,200	415,100	416,000	417,100	418,700	420,200	421,800	423,300	424,800	426,300	427,700	429,200	430,600	432,200	109
110	407,900	409,100	410,300	411,700	413,000	414,400	415,800	417,200	418,500	419,800	421,300	423,300	425,200	427,100	429,000	430,900	432,700	434,600	436,400	438,200	440,200	110
111	408,000	409,600	411,200	413,000	414,800	416,500	418,300	420,100	421,900	423,600	425,500	427,800	430,100	432,400	434,700	436,900	439,200	441,400	443,700	445,900	448,300	111
112	408,100	410,100	412,200	414,300	416,500	418,600	420,900	423,100	425,300	427,400	429,700	432,400	435,100	437,700	440,400	443,000	445,700	448,300	450,900	453,500	456,300	112
113	408,200	410,600	413,100	415,700	418,200	420,800	423,400	426,000	428,600	431,200	433,900	437,000	440,000	443,000	446,100	449,100	452,100	455,100	458,200	461,200	464,300	113
114	408,300	411,100	414,000	417,000	419,900	422,900	426,000	429,000	432,000	435,000	438,100	441,500	444,900	448,300	451,800	455,200	458,600	462,000	465,400	468,800	472,400	114
115	408,400	411,600	414,900	418,300	421,700	425,100	428,500	431,900	435,400	438,800	442,300	446,100	449,900	453,700	457,500	461,200	465,000	468,900	472,700	476,500	480,400	115
116	408,500	412,100	415,800	419,600	423,400	427,200	431,000	434,900	438,700	442,600	446,500	450,700	454,800	459,000	463,100	467,300	471,500	475,700	479,900	484,100	488,400	116
117	408,600	412,600	416,800	420,900	425,100	429,300	433,600	437,800	442,100	446,400	450,700	455,200	459,800	464,300	468,800	473,400	478,000	482,600	487,200	491,800	496,500	117
118	408,700	413,200	417,700	422,300	426,900	431,500	436,100	440,800	445,500	450,200	454,900	459,800	464,700	469,600	474,500	479,500	484,400	489,400	494,400	499,400	504,500	118
119	408,800	413,700	418,600	423,600	428,600	433,600	438,700	443,700	448,900	454,000	459,100	464,400	469,600	474,900	480,200	485,500	490,900	496,300	501,700	507,100	512,500	119
120	408,800	414,200	419,500	424,900	430,300	435,700	441,200	446,700	452,200	457,800	463,300	468,900	474,600	480,200	485,900	491,600	497,400	503,100	508,900	514,700	520,600	120

WHEELER DAM
SPILLWAY DISCHARGE
IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	556.0	556.1	556.2	556.3	556.4	556.5	556.6	556.7	556.8	556.9	557.0	557.1	557.2	557.3	557.4	557.5	557.6	557.7	557.8	557.9	558.0	
1	1,600	1,600	1,610																			1
2	3,110	3,120	3,130																			2
3	4,700	4,720	4,740																			3
4	6,220	6,240	6,270																			4
5	7,810	7,840	7,870																			5
6	9,320	9,360	9,400																			6
7	10,920	10,960	11,010																			7
8	12,430	12,480	12,530																			8
9	14,030	14,080	14,140																			9
10	15,540	15,600	15,670																			10
11	17,140	17,210	17,270																			11
12	18,650	18,720	18,800																			12
13	20,240	20,330	20,410																			13
14	21,760	21,840	21,930																			14
15	23,350	23,450	23,540																			15
16	24,860	24,960	25,070																			16
17	26,460	26,570	26,670																			17
18	27,970	28,090	28,200																			18
19	29,570	29,690	29,810																			19
20	31,080	31,210	31,330																			20
21	32,680	32,810	32,940																			21
22	34,190	34,330	34,470																			22
23	35,780	35,930	36,070																			23
24	37,290	37,450	37,600																			24
25	38,890	39,050	39,210																			25
26	40,400	40,570	40,730																			26
27	42,000	42,170	42,340																			27
28	43,510	43,690	43,870																			28
29	45,110	45,290	45,470																			29
30	46,620	46,810	47,000																			30
31	48,210	48,410	48,610																			31
32	49,730	49,930	50,130																			32
33	51,320	51,530	51,740																			33
34	52,830	53,050	53,270																			34
35	54,430	54,650	54,870																			35
36	55,940	56,170	56,400																			36
37	57,540	57,770	58,010																			37
38	59,050	59,290	59,530																			38
39	60,650	60,890	61,140																			39
40	62,160	62,410	62,670																			40
41	63,750	64,010	64,270																			41
42	65,270	65,530	65,800																			42
43	66,860	67,140	67,410																			43
44	68,370	68,650	68,930																			44
45	69,970	70,260	70,540																			45
46	71,480	71,770	72,070																			46
47	73,080	73,380	73,670																			47
48	74,590	74,890	75,200																			48
49	76,190	76,500	76,810																			49
50	77,700	78,020	78,330																			50
51	79,290	79,620	79,940																			51
52	80,810	81,140	81,470																			52
53	82,400	82,740	83,070																			53
54	83,910	84,260	84,600																			54
55	85,510	85,860	86,210																			55
56	87,020	87,380	87,730																			56
57	88,620	88,980	89,340																			57
58	90,130	90,500	90,870																			58
59	91,730	92,100	92,470																			59
60	93,240	93,620	94,000																			60

See special instruction for preventing gate overflow on page 3.

WHEELER DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGE-MENT	HEADWATER ELEVATION																					GATE ARRANGE-MENT
	556.0	556.1	556.2	556.3	556.4	556.5	556.6	556.7	556.8	556.9	557.0	557.1	557.2	557.3	557.4	557.5	557.6	557.7	557.8	557.9	558.0	
61	97, 400	97, 800	98, 190																			61
62	101, 200	101, 600	102, 000																			62
63	105, 100	105, 500	105, 900																			63
64	108, 800	109, 200	109, 700																			64
65	112, 900	113, 400	113, 900																			65
66	116, 800	117, 200	117, 700																			66
67	120, 600	121, 100	121, 600																			67
68	124, 300	124, 800	125, 300																			68
69	128, 500	129, 000	129, 500																			69
70	132, 300	132, 800	133, 400																			70
71	136, 100	136, 700	137, 300																			71
72	139, 900	140, 400	141, 000																			72
73	144, 000	144, 600	145, 200																			73
74	147, 800	148, 400	149, 000																			74
75	151, 700	152, 300	152, 900																			75
76	155, 400	156, 000	156, 700																			76
77	159, 600	160, 200	160, 900																			77
78	163, 400	164, 000	164, 700																			78
79	167, 200	167, 900	168, 600																			79
80	170, 900	171, 600	172, 300																			80
81	175, 100	175, 800	176, 500	177, 200	178, 000	178, 700	179, 400	180, 100	180, 800	181, 500	182, 200	182, 900										81
82	178, 900	179, 600	180, 400	181, 100	181, 800	182, 600	183, 300	184, 000	184, 700	185, 400	186, 200	186, 900	187, 600	188, 300	189, 000	189, 800	190, 500	191, 200	191, 900	192, 600		82
83	182, 800	183, 500	184, 300	185, 000	185, 700	186, 500	187, 200	188, 000	188, 700	189, 400	190, 200	190, 900	191, 600	192, 400	193, 100	193, 800	194, 600	195, 300	196, 000	196, 800	197, 500	83
84	186, 500	187, 200	188, 000	188, 800	189, 500	190, 300	191, 000	191, 800	192, 500	193, 300	194, 000	194, 800	195, 500	196, 300	197, 000	197, 800	198, 500	199, 300	200, 100	200, 800	201, 600	84
85	196, 700	197, 500	198, 400	199, 200	200, 000	200, 800	201, 600	202, 400	203, 200	204, 000	204, 800	205, 700	206, 500	207, 300	208, 100	208, 900	209, 700	210, 500	211, 300	212, 100	212, 900	85
86	207, 000	207, 800	208, 700	209, 600	210, 500	211, 300	212, 200	213, 100	213, 900	214, 800	215, 700	216, 500	217, 400	218, 200	219, 100	220, 000	220, 800	221, 700	222, 500	223, 400	224, 300	86
87	217, 200	218, 200	219, 100	220, 000	220, 900	221, 900	222, 800	223, 700	224, 600	225, 500	226, 500	227, 400	228, 300	229, 200	230, 100	231, 000	232, 000	232, 900	233, 800	234, 700	235, 600	87
88	227, 500	228, 500	229, 400	230, 400	231, 400	232, 400	233, 400	234, 300	235, 300	236, 300	237, 300	238, 200	239, 200	240, 200	241, 200	242, 100	243, 100	244, 100	245, 000	246, 000	247, 000	88
89	237, 700	238, 800	239, 800	240, 800	241, 900	242, 900	244, 000	245, 000	246, 000	247, 000	248, 100	249, 100	250, 100	251, 200	252, 200	253, 200	254, 200	255, 300	256, 300	257, 300	258, 300	89
90	248, 000	249, 100	250, 200	251, 300	252, 400	253, 500	254, 500	255, 600	256, 700	257, 800	258, 900	260, 000	261, 100	262, 100	263, 200	264, 300	265, 400	266, 400	267, 500	268, 600	269, 700	90
91	258, 200	259, 400	260, 500	261, 700	262, 800	264, 000	265, 100	266, 300	267, 400	268, 600	269, 700	270, 800	272, 000	273, 100	274, 200	275, 400	276, 500	277, 600	278, 800	279, 900	281, 000	91
92	268, 500	269, 700	270, 900	272, 100	273, 300	274, 500	275, 700	276, 900	278, 100	279, 300	280, 500	281, 700	282, 900	284, 100	285, 300	286, 500	287, 600	288, 800	290, 000	291, 200	292, 400	92
93	278, 700	280, 000	281, 300	282, 500	283, 800	285, 000	286, 300	287, 500	288, 800	290, 100	291, 300	292, 600	293, 800	295, 000	296, 300	297, 500	298, 800	300, 000	301, 200	302, 500	303, 700	93
94	289, 000	290, 300	291, 600	292, 900	294, 200	295, 600	296, 900	298, 200	299, 500	300, 800	302, 100	303, 400	304, 700	306, 000	307, 300	308, 600	309, 900	311, 200	312, 500	313, 800	315, 100	94
95	299, 200	300, 600	302, 000	303, 300	304, 700	306, 100	307, 500	308, 800	310, 200	311, 600	312, 900	314, 300	315, 600	317, 000	318, 300	319, 700	321, 000	322, 400	323, 700	325, 100	326, 400	95
96	309, 500	310, 900	312, 300	313, 800	315, 200	316, 600	318, 000	319, 500	320, 900	322, 300	323, 700	325, 100	326, 600	328, 000	329, 400	330, 800	332, 200	333, 600	335, 000	336, 400	337, 800	96
97	319, 000	320, 500	322, 000	323, 500	324, 900	326, 400	327, 900	329, 300	330, 800	332, 300	333, 700	335, 200	336, 700	338, 100	339, 600	341, 000	342, 500	343, 900	345, 400	346, 800	348, 300	97
98	328, 600	330, 100	331, 600	333, 200	334, 700	336, 200	337, 700	339, 200	340, 700	342, 200	343, 700	345, 200	346, 800	348, 300	349, 800	351, 300	352, 800	354, 300	355, 800	357, 300	358, 800	98
99	338, 100	339, 700	341, 300	342, 800	344, 400	346, 000	347, 500	349, 100	350, 600	352, 200	353, 700	355, 300	356, 900	358, 400	360, 000	361, 500	363, 100	364, 600	366, 200	367, 700	369, 200	99
100	347, 700	349, 300	350, 900	352, 500	354, 200	355, 800	357, 400	359, 000	360, 500	362, 100	363, 700	365, 300	367, 000	368, 600	370, 200	371, 800	373, 400	375, 000	376, 600	378, 200	379, 700	100
101	357, 300	358, 900	360, 600	362, 200	363, 900	365, 500	367, 200	368, 800	370, 500	372, 100	373, 700	375, 400	377, 100	378, 700	380, 400	382, 000	383, 700	385, 300	387, 000	388, 600	390, 200	101
102	366, 800	368, 500	370, 200	371, 900	373, 600	375, 300	377, 000	378, 700	380, 400	382, 000	383, 700	385, 400	387, 200	388, 900	390, 600	392, 300	394, 000	395, 700	397, 400	399, 000	400, 700	102
103	376, 400	378, 100	379, 900	381, 600	383, 400	385, 100	386, 800	388, 600	390, 300	392, 000	393, 700	395, 500	397, 300	399, 000	400, 800	402, 500	404, 300	406, 000	407, 800	409, 500	411, 200	103
104	385, 900	387, 700	389, 500	391, 300	393, 100	394, 900	396, 700	398, 400	400, 200	402, 000	403, 700	405, 500	407, 400	409, 200	411, 000	412, 800	414, 600	416, 400	418, 200	419, 900	421, 700	104
105	395, 500	397, 300	399, 200	401, 000	402, 900	404, 700	406, 500	408, 300	410, 100	411, 900	413, 700	415, 600	417, 500	419, 300	421, 200	423, 000	424, 900	426, 700	428, 600	430, 400	432, 200	105
106	405, 000	406, 900	408, 800	410, 700	412, 600	414, 500	416, 300	418, 200	420, 000	421, 900	423, 700	425, 600	427, 600	429, 500	431, 400	433, 300	435, 200	437, 100	439, 000	440, 800	442, 700	106
107	414, 600	416, 500	418, 500	420, 400	422, 300	424, 200	426, 100	428, 000	429, 900	431, 800	433, 700	435, 700	437, 700	439, 600	441, 600	443, 500	445, 500	447, 400	449, 400	451, 300	453, 200	107
108	424, 200	426, 200	428, 100	430, 100	432, 100	434, 000	436, 000	437, 900	439, 800	441, 800	443, 700	445, 700	447, 800	449, 800	451, 800	453, 800	455, 800	457, 800	459, 800	461, 700	463, 700	108
109	432, 200	434, 500	436, 800	439, 100	441, 400	443, 700	446, 000	448, 300	450, 600	452, 800	455, 100	457, 500	459, 900	462, 200	464, 600	467, 000	469, 300	471, 700	474, 000	476, 300	478, 700	109
110	440, 200	442, 900	445, 500	448, 100	450, 800	453, 400	456, 000	458, 600	461, 300	463, 900	466, 500	469, 200	472, 000	474, 700	477, 400	480, 100	482, 800	485, 500	488, 200	490, 900	493, 700	110
111	448, 300	451, 200	454, 200	457, 100	460, 100	463, 100	466, 000	469, 000	472, 000	474, 900	477, 900	481, 000	484, 100	487, 100	490, 200	493, 300	496, 300	499, 400	502, 500	505, 600	508, 600	111
112	456, 300	459, 600	462, 900	466, 200	469, 500	472, 800	476, 100	479, 400	482, 700	486, 000	489, 300	492, 800	496, 200	499, 600	503, 000	506, 400	509, 900	513, 300	516, 700	520, 200	523, 600	112
113	464, 300	467, 900	471, 600	475, 200	478, 800	482, 400	486, 100	489, 700	493, 400	497, 100	500, 800	504, 500	508, 300	512, 000	515, 800	519, 600	523, 400	527, 200	531, 000	534, 800	538, 600	113
114	472, 400	476, 300	480, 200	484, 200	488, 100	492, 100	496, 100	500, 100	504, 100	508, 100	512, 200	516, 300	520, 400	524, 500	528, 600	532, 700	536, 900	541, 000	545, 200	549, 400	553, 600	114
115	480, 400	484, 700	488, 900	493, 200	497, 500	501, 800	506, 100	510, 500	514, 800	519, 200	523, 600	528, 000	532, 500	536, 900	541, 400	545, 900	550, 400	554, 900	559, 500	564, 000	568, 600	115
116	488, 400	493, 000	497, 600	502, 200	506, 800	511, 500	516, 100	520, 800	525, 500	530, 200	535, 000	539, 800	544, 600	549, 400	554, 200	559, 100	563, 900	568, 800	573, 700	578, 600	583, 500	116
117	496, 500	501, 400	506, 300	511, 200	516, 200	521, 200	526, 200	531, 200	536, 200	541, 300	546, 400	551, 500	556, 700	561, 800	567, 000	572, 200	577, 400	582, 700	587, 900	593, 200	598, 500	117
118	504, 500	509, 700	515, 000	520, 200	525, 500	530, 900	536, 200	541, 600	546, 900	552, 400	557, 800	563, 300	568, 800	574, 300	579, 800	585, 400	591, 000	596, 600	602, 200	607, 800	613, 500	118
119	512, 500	518, 100	523, 700	529, 300	534, 900	540, 500	546, 200	551, 900	557, 700	563, 400	569, 200	575, 000	580, 900	586, 700	592, 600	598, 500	604, 500	610, 400	616, 400	622, 400	628, 500	119
120	520, 600	526, 400	532, 300	538, 300	544, 200	550, 200	556, 200	562, 300	568, 400	574, 500	580, 600	586, 800	593, 000	599, 200	605, 400	611, 700	618, 000	624, 300	630, 700	637, 000	643, 500	120

See special instruction for preventing gate overflow on page 3.

WHEELER DAM

SPILLWAY DISCHARGE

IN CUBIC FEET PER SECOND

GATE ARRANGEMENT	HEADWATER ELEVATION																					GATE ARRANGEMENT
	558.0	558.1	558.2	558.3	558.4	558.5	558.6	558.7	558.8	558.9	559.0	559.1	559.2	559.3	559.4	559.5	559.6	559.7	559.8	559.9	560.0	
81																						81
82																						82
83	197,500	198,200	199,000	199,700	200,400	201,200	201,900	202,600														83
84	201,600	202,300	203,000	203,800	204,500	205,300	206,000	206,800	207,500	208,300	209,000	209,800	210,500	211,300	212,000	212,800						84
85	212,900	213,700	214,500	215,300	216,100	216,900	217,700	218,500	219,300	220,100	220,900	221,700	222,500	223,300	224,100	224,900						85
86	224,300	225,100	226,000	226,800	227,700	228,500	229,400	230,200	231,100	231,900	232,800	233,600	234,500	235,300	236,200	237,000						86
87	235,600	236,500	237,400	238,300	239,200	240,100	241,000	242,000	242,900	243,800	244,700	245,600	246,500	247,400	248,300	249,200						87
88	247,000	247,900	248,900	249,800	250,800	251,800	252,700	253,700	254,600	255,600	256,500	257,500	258,400	259,400	260,300	261,300						88
89	258,300	259,300	260,300	261,400	262,400	263,400	264,400	265,400	266,400	267,400	268,400	269,400	270,400	271,400	272,400	273,400						89
90	269,700	270,700	271,800	272,900	273,900	275,000	276,100	277,100	278,200	279,200	280,300	281,300	282,400	283,500	284,500	285,600						90
91	281,000	282,100	283,300	284,400	285,500	286,600	287,700	288,800	289,900	291,100	292,200	293,300	294,400	295,500	296,600	297,700						91
92	292,400	293,500	294,700	295,900	297,100	298,200	299,400	300,600	301,700	302,900	304,000	305,200	306,400	307,500	308,700	309,800						92
93	303,700	304,900	306,200	307,400	308,600	309,800	311,100	312,300	313,500	314,700	315,900	317,100	318,300	319,600	320,800	322,000						93
94	315,100	316,300	317,600	318,900	320,200	321,500	322,700	324,000	325,300	326,500	327,800	329,100	330,300	331,600	332,800	334,100						94
95	326,400	327,700	329,100	330,400	331,700	333,100	334,400	335,700	337,000	338,400	339,700	341,000	342,300	343,600	344,900	346,200						95
96	337,800	339,200	340,500	341,900	343,300	344,700	346,100	347,400	348,800	350,200	351,600	352,900	354,300	355,600	357,000	358,400	359,700	361,100	362,400	363,800	365,100	96
97	348,300	349,700	351,100	352,600	354,000	355,400	356,900	358,300	359,700	361,100	362,500	363,900	365,400	366,800	368,200	369,600	371,000	372,400	373,800	375,200	376,600	97
98	358,800	360,200	361,700	363,200	364,700	366,200	367,600	369,100	370,600	372,000	373,500	375,000	376,400	377,900	379,300	380,800	382,200	383,700	385,100	386,500	388,000	98
99	369,200	370,800	372,300	373,900	375,400	376,900	378,400	380,000	381,500	383,000	384,500	386,000	387,500	389,000	390,500	392,000	393,500	395,000	396,500	397,900	399,400	99
100	379,700	381,300	382,900	384,500	386,100	387,600	389,200	390,800	392,400	393,900	395,500	397,000	398,600	400,100	401,700	403,200	404,700	406,300	407,800	409,300	410,800	100
101	390,200	391,900	393,500	395,100	396,800	398,400	400,000	401,600	403,200	404,800	406,400	408,000	409,600	411,200	412,800	414,400	416,000	417,600	419,100	420,700	422,300	101
102	400,700	402,400	404,100	405,800	407,500	409,100	410,800	412,500	414,100	415,800	417,400	419,100	420,700	422,400	424,000	425,600	427,200	428,900	430,500	432,100	433,700	102
103	411,200	413,000	414,700	416,400	418,200	419,900	421,600	423,300	425,000	426,700	428,400	430,100	431,800	433,500	435,100	436,800	438,500	440,200	441,800	443,500	445,100	103
104	421,700	423,500	425,300	427,100	428,800	430,600	432,400	434,100	435,900	437,600	439,400	441,100	442,900	444,600	446,300	448,000	449,700	451,500	453,200	454,900	456,600	104
105	432,200	434,100	435,900	437,700	439,500	441,400	443,200	445,000	446,800	448,600	450,400	452,100	453,900	455,700	457,500	459,200	461,000	462,800	464,500	466,300	468,000	105
106	442,700	444,600	446,500	448,400	450,200	452,100	454,000	455,800	457,700	459,500	461,300	463,200	465,000	466,800	468,600	470,400	472,300	474,100	475,900	477,600	479,400	106
107	453,200	455,100	457,100	459,000	460,900	462,800	464,700	466,600	468,500	470,400	472,300	474,200	476,100	477,900	479,800	481,700	483,500	485,400	487,200	489,000	490,900	107
108	463,700	465,700	467,700	469,600	471,600	473,600	475,500	477,500	479,400	481,400	483,300	485,200	487,100	489,100	491,000	492,900	494,800	496,700	498,500	500,400	502,300	108
109	478,700	481,000	483,400	485,700	488,100	490,400	492,800	495,100	497,400	499,800	502,100	504,400	506,700	509,100	511,400	513,700	516,000	518,300	520,600	522,900	525,200	109
110	493,700	496,400	499,100	501,800	504,600	507,300	510,000	512,700	515,500	518,200	520,900	523,600	526,300	529,100	531,800	534,500	537,200	539,900	542,700	545,400	548,100	110
111	508,600	511,700	514,800	517,900	521,000	524,200	527,300	530,400	533,500	536,600	539,700	542,800	546,000	549,100	552,200	555,300	558,400	561,600	564,700	567,800	571,000	111
112	523,600	527,100	530,600	534,000	537,500	541,000	544,500	548,000	551,500	555,000	558,500	562,000	565,600	569,100	572,600	576,100	579,700	583,200	586,800	590,300	593,900	112
113	538,600	542,400	546,300	550,100	554,000	557,900	561,700	565,600	569,500	573,400	577,300	581,200	585,200	589,100	593,000	597,000	600,900	604,900	608,800	612,800	616,800	113
114	553,600	557,800	562,000	566,200	570,500	574,700	579,000	583,300	587,500	591,800	596,100	600,400	604,800	609,100	613,400	617,800	622,100	626,500	630,900	635,300	639,700	114
115	568,600	573,100	577,700	582,300	587,000	591,600	596,200	600,900	605,600	610,200	614,900	619,600	624,400	629,100	633,800	638,600	643,400	648,100	652,900	657,700	662,600	115
116	583,500	588,500	593,500	598,400	603,400	608,500	613,500	618,500	623,600	628,700	633,700	638,900	644,000	649,100	654,300	659,400	664,600	669,800	675,000	680,200	685,400	116
117	598,500	603,800	609,200	614,500	619,900	625,300	630,700	636,200	641,600	647,100	652,600	658,100	663,600	669,100	674,700	680,200	685,800	691,400	697,000	702,700	708,300	117
118	613,500	619,200	624,900	630,600	636,400	642,200	648,000	653,800	659,600	665,500	671,400	677,300	683,200	689,100	695,100	701,100	707,100	713,100	719,100	725,200	731,200	118
119	628,500	634,500	640,600	646,700	652,900	659,000	665,200	671,400	677,600	683,900	690,200	696,500	702,800	709,100	715,500	721,900	728,300	734,700	741,200	747,600	754,100	119
120	643,500	649,900	656,400	662,800	669,400	675,900	682,500	689,000	695,700	702,300	709,000	715,700	722,400	729,100	735,900	742,700	749,500	756,400	763,200	770,100	777,000	120

See special instruction for preventing gate overflow on page 3.

WHEELER DAM
DISCHARGE PER TRASH GATE
IN CUBIC FEET PER SECOND

Gate Indicator Reading	HEADWATER ELEVATION																					Gate Indicator Reading
	550.0	550.2	550.4	550.6	550.8	551.0	551.2	551.4	551.6	551.8	552.0	552.2	552.4	552.6	552.8	553.0	553.2	553.4	553.6	553.8	554.0	
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	20	40	70	3
2	0	0	0	0	0	0	0	0	0	0	0	0	5	20	40	70	100	140	180	220	270	2
1	0	0	0	0	0	0	0	5	20	40	70	100	140	180	220	270	330	380	440	500	570	1
0	0	0	5	20	40	70	100	140	180	220	270	330	380	440	500	570	640	710	790	870	950	0

Gate Indicator Reading	HEADWATER ELEVATION																					Gate Indicator Reading
	554.0	554.2	554.4	554.6	554.8	555.0	555.2	555.4	555.6	555.8	556.0	556.2	556.4*	556.6*	556.8*	557.0*	557.2*	557.4*	557.6*	557.8*	558.0*	
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
5	0	0	0	0	0	0	0	5	20	40	70	100	130	160	180	200	220	240	260	280	300	5
4	0	0	5	20	40	70	100	140	180	220	270	330	380	420	460	500	540	580	610	650	680	4
3	70	100	140	180	220	270	330	380	440	500	570	640	710	770	830	880	940	990	1040	1090	1140	3
2	270	330	380	440	500	570	640	710	790	870	950	1040	1120	1200	1270	1340	1410	1470	1540	1600	1660	2
1	570	640	710	790	870	950	1040	1130	1220	1310	1410	1510	1610	1700	1780	1860	1940	2020	2100	2180	2250	1
0	950	1040	1130	1220	1310	1410	1510	1610	1720	1820	1930	2050	2160	2260	2360	2450	2550	2640	2730	2820	2900	0

Gate Indicator Reading	HEADWATER ELEVATION																					Gate Indicator Reading
	558.0*	558.2*	558.4*	558.6*	558.8*	559.0*	559.2*	559.4*	559.6*	559.8*	560.0*	560.2	560.4	560.6	560.8	561.0	561.2	561.4	561.6	561.8	562.0	
6	0	0	0	0	0	0	0	0	0	0	0											6
5	300	320	330	350	370	380	400	410	430	440	460											5
4	680	710	740	780	810	840	870	900	930	950	980											4
3	1140	1180	1230	1270	1320	1360	1410	1450	1490	1530	1570											3
2	1660	1720	1780	1840	1900	1950	2010	2060	2120	2170	2220											2
1	2250	2320	2400	2470	2530	2600	2670	2740	2810	2870	2940											1
0	2900	2990	3070	3150	3240	3320	3400	3480	3560	3640	3710											0

MARCH 2004

Trash gate discharge does not include portion that would flow over fully raised gate (top elevation 556.28) because this discharge is already included in the spillway tables.

CDQ000020080021

Attachment 9

L58 090529 80Q

Bellefonte Nuclear Units 3&4

Hydrology Project

Basis for
Dam Spillway Gate/Outlet Open Configuration
for Flood Analyses

Tennessee Valley Authority

Revision 0 - May 29, 2009

Basis for
Dam Spillway Gate/Outlet Open Configuration
for Flood Analyses

Issue

TVA maintains that all discharge outlets (spillway gates, sluice gates, and valves) for projects in the reservoir system can be placed in the fully open position for the passage of water when and as needed. The specific language contained in the Final Safety Analysis Report (FSAR) for the operating plants (WBN, SQN, and BFN) and for the BLN COLA is - "All gates were determined to be operable without failures during the flood." This evaluation provides the rationale and justification for this position.

Background

The TVA reservoir system consists of 48 dams located within the Tennessee River Basin. There are a total of 424 spillway gates at the 28 dams with gates. The spillway gates consist of a variety of types including: radial, vertical lift, fixed-roller lift, fixed-wheel lift, slide, drum, hinge, and Stoney. There are also several projects which have sluice gates and valves for discharge of water from the dam.

Basis for the All Gates/Outlets Open

1. Inspection of TVA dams is an integral part of TVA's dam safety program to ensure their safe and reliable operation. Plant operations staff is tasked to perform monthly walk-through inspections on high and significant hazard dams. Low hazard dams are performed on a quarterly basis. Most of the larger dams are classified as high hazard, 10 dams are classified significant hazard and 3 dams are classified low hazard. Inspections are scheduled and tracked in the TVA wide maintenance database (EMPAC) and a checklist is utilized to ensure a complete inspection. The inspection includes all civil, mechanical and electrical features. Special inspections are also completed after significant earthquake or severe flood events. A "Dam Safety Awareness Course" is provided to inspectors and site personnel as part of their training.

   These inspections provide confidence that observable issues which could impact the ability to fully open gates/outlets when needed are identified and are prioritized for resolution commensurate with the potential impact of the deficiencies on dam safety.

2. The Dam Safety Engineering staff performs comprehensive inspections of TVA dams every 5 years which are consistent with the formal inspection described in the Federal Guidelines for Dam Safety. Preparation for these inspections includes reviewing previous inspection reports, status of previous recommendations, history of the project, and a review of available instrumentation data and analysis results. An intermediate walk through inspection is performed every 15 months for high and

significant hazard dams. For the low hazard dams the intermediate inspection is performed every 2 1/2 years. Special unscheduled inspections are also performed when needed to resolve problems or deficiencies identified at TVA dams. Rope access for close-up inspection of spillway gates and decks, downstream faces of the dams and sloped sections of penstocks and tunnels are a part of TVA's inspection. Remote operated vehicle (ROV) inspections of toe drains, upstream face of dams, sluice gates and exterior lock walls are also employed.

All inspections are documented in a report, issued and archived in TVA Electronic Data Management System (EDMS) and Business Support Library (BSL). The Dam Safety Engineering staff serve as emergency technical contacts available on a 24 hour basis for emergency situations that could affect the integrity of a dam. Follow-up maintenance associated with the issues identified from these inspections is prioritized commensurate with the potential impact of the deficiencies on dam safety.

These thorough engineering inspections and subsequent maintenance provide confidence that existing and potentially eminent issues associated with gate/outlet functionality are identified and are prioritized for resolution.

3. Emergency Action Plans (EAP) are prepared by TVA-River Operations for each project to minimize life and property loss by defining responsibilities and providing emergency notification guidelines for TVA personnel to follow upon indication of possible, impending, or actual failure of a TVA dam. The EAP is designed to provide TVA personnel with the information needed for a quick and effective response to a TVA dam safety emergency.

   In a dam safety emergency the River Operations Emergency Operations Center (REOC) and the Knoxville Emergency Operations Center (KEOC) would be activated to coordinate overall emergency operations. Once the emergency operations centers are activated, clearly defined organizational responsibilities and resources from across the TVA agency are available to deal with the emergency. The EAP clearly defines indicators of potential or actual emergency conditions that warrant special attention and immediate evaluation. Among these indicators are mechanical or electrical malfunctions which include: cranes, spillway gates, sluice gates, valves, spillway and sluice gate operating machinery and generators (primary or emergency). During such emergencies on-site TVA staff is authorized to contact any and all sources deemed necessary to procure emergency equipment, materials and labor to prevent or lessen the magnitude of the impending emergency.

   TVA's staff is maintained in a readiness condition by being knowledgeable of EAP and procedure requirements through a comprehensive training and exercise program. The Dam Safety Exercise Program consists of four types of activities: Orientation Seminar, Drills, Tabletop Exercises, and Functional Exercises. Orientation seminars, drills and tabletop exercises are used to train both TVA staff and outside organizations that would be involved with a TVA dam safety emergency. Seminars, drills, and tabletop exercises are developed and held as needed, and generally target specific groups or organizations with specific training needs. Typically, one or two functional exercises are held each year. Each functional exercise focuses on one dam in the TVA system and uses a scenario designed specifically for that project. An exercise critique is held after each exercise to provide participants with the opportunity to comment on the exercise and to identify improvements/changes needed in the EAP, the notification procedures, and the exercise process.

4. In the event that flooding conditions arise that have the potential to impact any of the three TVA operating nuclear plants, operations, maintenance and engineering Nuclear Power Group condition response teams would be assembled at the nuclear plants and corporate offices to assist in the identification and direction of resources required to address and resolve issues such as non-functional gates/outlets and crane malfunctions as well as to develop contingency plans to mitigate impacts. In addition to the normal contingency of TVA maintenance and operational personnel located at dam sites, TVA has substantial additional internal resources, including the Power Services Shops, the Heavy Equipment Division and River Operations Engineering Support Services as well as external vendors, which would be applied as needed to resolve any issues that could impact gate/outlet function.

   These TVA internal resources and external vendors have the requisite experience, expertise and equipment to accomplish any needed maintenance, repairs or workarounds to provide a high level of confidence that issues that may prevent gates from opening will be resolved.

Conclusion

The TVA plant personnel periodic inspections, the intermediate and 5-year dam safety engineering inspections and the significant capability of the emergency response teams to direct and manage resources to address issues potentially impacting gate/outlet functionality provide a high level of confidence that the all gates/outlets open configuration used in the flood analysis is reasonable and valid.

Prepared: for Greg Lowe   **Date:** 5/28/09

Concurrence: Charles L Buch   **Date:** 5/28/09

Approved: for K.R. Spates   **Date:** 5/29/09

CDQ000020080021

Attachment 10

EDMS No.

L58 090908 001

Bellefonte Nuclear Units 3&4

Hydrology Project
Dam Lock Gate Technical Evaluation for the PMF

Tennessee Valley Authority

Revision 0

March 26, 2008

Prepared: [signature] Date: 3/26/09

Checked: J. V. Peyton Date: 3-26-2009

RO Concurrence: Russell W Tompkins Date: 8-24-09

NPG Approval: [signature] Date: 9-4-09

[initials] 8/20/09 PBS 8/31/09

Background

During the course of preparing the Dam Rating Curves (DRC) for the TVA Nuclear Probable Maximum Flood (PMF) documentation, the continued stability of the dam lock gates under PMF conditions was documented in the DRC calculations as an Unverified Assumption (UVA). While the initial design of the lock gates considered loading conditions that are typical of normal operations (including barge impact loading), most cases neglected the significantly increased headwater conditions that would be encountered in a PMF. The purpose of this evaluation is to document the basis for maintaining the lock gates in a stable configuration for the range of headwater elevations considered for the PMF and to support removal of the UVA from the DRC calculations.

Assumptions

For the purpose of this evaluation, the following assumptions are made:

1. Assumption: *The original gate design allowable stresses were based on the Allowable Stress Design (ASD) method as provided in the Army Corps of Engineers (COE) Design of Hydraulic Steel Structures and the 1989 AISC 9th edition ASD Manual.*

   Although the 1989 AISC manual post-dates the lock gate design, the concepts and factors utilized from this manual have not changed. In addition, allowable stresses as shown on Watts Bar Dam drawing 64W203-1 (Design Data) are consistent with the allowable stresses provided in the design manuals.

2. Assumption: *The lock gates are designed for a hydrostatic impact loading of 15 feet of water applied to the top 15 feet of the lock gate in addition to the hydrostatic load due to design maximum headwater conditions.*

   This impact loading is required by the Army Corps of Engineers Lock Gate and Operating Equipment Design Manual (Section 1-9(b)) and is typically shown in the Water Load Diagram on the Lock Gate Design Data drawings (e.g., 64N202, R0). During PMF conditions, navigation on the rivers will cease and barges are not likely to be moored above the dams for barge operational safety considerations. In addition, at the PMF headwater elevation considered, a large cushion of water exists between the water surface and the top of the gates (e.g., Watts Bar and Melton Hill have PMF elevations approximately 20 feet over the top of the gates considered in this evaluation). As a result, major gate impacts from river borne objects are not expected during the PMF[1]. Since major impacts are not expected, the design

[1] Impact loads were considered additive to design hydrostatic pressure loads up to approximately 5 feet over the top of the gate (see Attachment 1). When the flood headwater is higher than 5 feet over the lock gate, impact loads are not considered.

margin built into the gate design for impact loading can be utilized to off-set the increased lock gate stresses due to the hydrostatic loads from the PMF.

3. <u>Assumption</u>: *The headwater and tailwater elevations from the TVA Hydrology Project DRC calculations can be utilized to determine the differential loading on the lock gates.*

   These calculations are independently documented as a QA record under the calculations identifiers CDQ000020080001 through CDQ000020080020 and are retrievable from EDMS. (Note: Following completion of the SOCH PMF analysis and inclusion of the "loop tailwater rating effect", the headwater and tailwater elevations used in this evaluation will be verified to be technically acceptable.)

4. <u>Assumption</u>: *The operability of the gates a PMF is not a requirement.*

   Although lock gate operability is obviously a river navigational objective following a PMF, no credit is taken in the Nuclear Plant safety analysis for river navigation capability post-PMF. Inelastic but stable gate configurations are acceptable.

5. <u>Assumption</u>: *The auxiliary gates at Nickajack are adequate since the gates were analyzed and modified for PMF conditions.*

   The analysis of these gates is documented in River Operations Group calculation, *<u>Upper Miter Gate Analysis for Probable Maximum Flood.</u>* (Letter from G. L. Wimberly to J. H. Coulson, dated March 19, 1991, RIMS No. B65910322176)

6. <u>Assumption</u>: Downstream lock gates are assumed open for this evaluation

   During a PMF, the upstream lock gates will be in their normal operational configuration.

Evaluation

The cause of the overloading of the gates in a PMF event is the differential in headwater and tailwater elevations. Once the elevation of the tailwater is above the sill of the gate, the tailwater effectively cancels out some of the loading. All loads are treated as a static hydrostatic loading which is justified in the TVA Report "Nickajack Auxiliary Lock: Forces on Upstream Miter gate Due to Overflow during Probable Maximum Flood."

The impact loadings are added to the design load as shown on relevant TVA Upper Lock Gate Design Data drawings. This load is considered a portion of the design capacity in accordance with the second assumption noted above.[2]

The gates are evaluated by comparing PMF Design Margin Ratios for each dam. The PMF Design Margin Ratio is defined in this evaluation as (Original Hydrostatic Lateral Design Load + Impact Load)/ (PMF Critical Lateral Load). The PMF Critical Horizontal Load is the combination of PMF headwater and tailwater (from the DRC calculations) that creates the highest hydrostatic load on the lock gate (Note: A summary of the results of this evaluation is provided in Attachment 1). ASD design limits stress to 60% of the specified yield strength of the steel. As defined in Chapter 3 of the Sequoyah and Watts Bar Nuclear Plant FSARs, the limiting stress can be increased by 50% to a total of 90% of the yield capacity for extreme environmental load conditions such as severe seismic events, tornados and internal/external flooding events as well as for severe accident pressurization. In other words, this allows the numerator of the PMF Design Margin Ratio to be multiplied by 1.5. Reduction in allowable bending stresses due to compression flange buckling is not required due to the lateral support the gate skin plate and adjacent structural members provide the compression flange in areas of large compressive bending moment stresses.

The increase in allowable stress and the additional capacity for impact load shows that all the lock gates except for the gates at Melton Hill and Watts Bar have a PMF Design Margin Ratio greater than one (see Table 1). The PMF Design Margin Ratios at these two dams are 0.73 and 0.81, respectively. These low margins occur due to the height of the dams and the rate at which the tailwater elevation rises.

The geometry of the gates adds a significant amount of load carrying capacity not considered in these PMF Design Margin Ratios. The miter design will put large amounts of compression into the gates. This compression reduces the tension due to bending moments in the gate along the strong axis of the girders. The concrete lock wall has a large capacity to absorb these forces. Also, even with the increase in design strength of 50%, the actual stress is still 10% less than the specified yield strength of the steel. Due to these factors, it is not uncommon for structures to carry loads much larger than the loads for which the structures were designed. While there may be local failures such as skin plate yielding or localized buckling, it is not expected that the gates will fail catastrophically.

[2] As shown in Attachment 1, combining the hydrostatic water pressure load from the rising flood headwater up to approximately 5 feet over the top of the gate with the design impact load will not result in lock gate failure. For this condition, lock gate stresses are expected to be less than material yield strength.

Table 1: Summary - PMF Design Margin Ratio

TVA Dam	Adjusted PMF Design Margin Ratio
Guntersville (main)	2.03
Guntersville (auxiliary)	2.26
Fort Loudon	1.16
Melton Hill	0.73
Watts Bar	0.81
Chickamauga	2.10

To analyze the gates at Watts Bar and Melton Hill in more detail, the operational stress analysis drawings were utilized at both dams to obtain the existing calculated design stresses in the upper lock gates. Using these originally calculated stresses, the design stresses from the PMF loading scenarios can be extrapolated.

Analysis of the Watts Bar Lock gates was performed using the original loading considerations and the lock gate stress analysis results provided on drawing 64W203-1, R0. The maximum stress for the highest loaded lock gate structural component (bottom girder in the lock gate) is 27.92 ksi. Other component stresses provided on the drawing are less in magnitude than the lock gate girder stress. In addition, concrete stresses can be increased by a factor greater than that permitted for structural steel stresses. Since there is at least a 2 ksi margin to steel yielding, the lock gates will continue to function for the PMF elevations considered in the DRC calculation.

The lock gates at the Melton Hill dam are more difficult to analyze since the stresses developed during the PMF are closer to the steel yield stress. The original design basis analysis for the PMF assumed that the total Melton Hill dam structure failed at an elevation of 805 feet. As shown in Attachment 1 (for Melton Hill), for the PMF elevations at 809.27 feet and below, the allowable stresses in the structural steel gates will remain less than 0.9 x Fy, demonstrating that elastic response of the gate material and small deflections will be maintained for the original FSAR Nuclear Plant PMF analysis. Using the original loading considerations and the lock gate stress analysis results provided on drawing 64N202, R0, the stress at the maximum elevation of the dam rating curve of 820 feet for the highest loaded lock gate girder (bottom girder in the lock gate) is 29.4 ksi (Ref: CDQ000020080013, EDMS No. L58090210002), slightly less than the 32 ksi yield strength of the A373 girder steel. The stress in the skin plate and the girder/skin plate combination (22.73 ksi and 38.6 ksi, respectively) indicates that some localized buckling may occur in the skin plate at the 820 feet elevation.

The localized buckling in the skin plate of the Melton Hill lock gate for the 820 feet elevation will not result in functional failure of the gate structure. The impact of the localized buckling (caused by skin plate compression resulting from Poisson's ration of the flexural tension in the skin plate) is limited due to restrained conditions provided by the intercostal supports and the girder flanges and due to the localized nature of the skin plate high stressed regions. The localized skin plate buckling would increase the calculated 29.4

ksi elastic stress of the composite girder/plate section due to the reduced flexural effectiveness of the skin plate, potentially increasing the composite section stress slightly above the 32 ksi yield stress. Since the ultimate strength of the A373 steel is at least a factor of 1.8 higher than yield strength, the expected result will be a stable, functional gate with some increased deflection at the gate centerline and at the mitered joint with the adjacent gate.

The other main problem encountered is the weight of the water flowing over the gates. Lock gates are not designed to take this type of load. The expected result is that the weight of the water above the gate will further compress the 1.5 inch rubber seal at the bottom of the lock gate into the embedded steel plate on the concrete sill until the vertical weight of the water head over the gate and the weight of the gate is equalized by the resistance of the compressed rubber seal and concrete sill. Although the downward deflection is self-limiting, the navigational functionality of the lock gates may be impaired. As noted previously in Assumption 4, post-PMF navigational functionality is not required to mitigate the consequences of the PMF event at the TVA Nuclear sites.

Conclusion

While the upper lock gates in this evaluation may have increased leakage and minor localized skin pate buckling or yielding, it can be stated with a reasonable degree of engineering judgment that the gates will not fail catastrophically during a PMF event. The upper lock gates will potentially be inoperable at the conclusion of the PMF from the excessive deflection the gates are likely to undergo.

Attachment 1

Dam	Adjusted FOS
Guntersville (main)	2.03
Guntersville (aux)	2.26
Ft. Loudoun	1.16
Melton Hill	0.73
Watts Bar	0.81
Chickamauga	2.10

Summary of Gate Dimensions and Loading

Lock	Design HW (ft)	Top of Gate (ft)	Gate Sill (ft)	Gate Height (ft)	Design Load (lb/ft)	Impact Load (lb/ft)	Total Design Load (lb/ft)	50% increase (lb/ft)	Critical Load (lb/ft)	Design Margin Ratio
Guntersville - Main	595	599.38	578	21.38	9017	11120	20136	30205	14889	2.03
Guntersville - Aux	595	597.11	570	27.11	19500	8995	28495	42742	18879	2.26
Ft. Loudoun	815	818.67	777	41.67	45053	10455	55508	83262	71862	1.16
Melton Hill	795	800.44	776.75	23.69	10392	12112	22503	33755	45979	0.73
Watts Bar	745	748.67	719.67	29	20018	10455	30473	45710	56410	0.81
Chickamauga	682.5	689.17	662	27.17	13112	13263	26375	39562	18820	2.10
									Impact Ld + Design Ld 5ft Cover	**%FY**
Guntersville - Main					9017	11120	20136	30205	20462	0.61
Guntersville - Aux					19500	8995	28495	42742	20179	0.42
Ft. Loudoun					45053	10455	55508	83262	78488	0.85
Melton Hill					10392	12112	22503	33755	23296	0.62
Nickajack - Aux					7661	12243	19904	29856	30252	0.91
Watts Bar					20018	10455	30473	45710	48091	0.95
Chickamauga					13112	13263	26375	39562	31275	0.71

Guntersville Main Lock

Top of Gate*	599.38
Gate Sill*	578
HW Design*	595

Load Condition	HW Elev (ft)	TW Elev (ft)	HW-TW (ft)	Downstream Force (lb/ft)	Upstream Force (lb/ft)	DS-US (lb/ft)			
A	595	-	-	9017	0	9017	Design Condition		
C	600	593.77	6.23	15089	7759	7330			
C	602.5	595.86	6.64	18424	9952	8472			
C	605	597.95	7.05	21759	12418	9342			
D	607	599.64	7.36	24428	14609	9819			
D	608.8	601.19	7.61	26829	16676	10153			
D	611	602.67	8.33	29764	18651	11113			
D	613	604	9	32432	20425	12007			
D	615	605.33	9.67	35100	22200	12901			
D	617.5	607.01	10.49	38436	24441	13995			
D	619	608.18	10.82	40437	26002	14435			
D	620	609.04	10.96	41771	27149	14622			
D	622	610.88	11.12	44439	29604	14835			
D	624	612.84	11.16	47107	32219	14889		FOS=	0.605614

* Source: TVA Drawing 64N202, R0

Guntersville Auxiliary Lock

Top of Gate	597.11
Gate Sill	570
HW Design	595

Load Condition	HW Elev (ft)	TW Elev (ft)	HW-TW (ft)	Downstream Force (lb/ft)	Upstream Force (lb/ft)	DS-US (lb/ft)			
A	595	-	-	19500	0	19500	Design Condition		
C	600	593.77	6.23	27819	17628	10191			
C	602.5	595.86	6.64	32049	20865	11184			
D	605	597.95	7.05	36278	24352	11926			
D	607	599.64	7.36	39661	27210	12451			
D	608.8	601.19	7.61	42706	29832	12874			
D	611	602.67	8.33	46428	32336	14092			
D	613	604	9	49811	34586	15225			
D	615	605.33	9.67	53194	36836	16358			
D	617.5	607.01	10.49	57424	39678	17746			
D	619	608.18	10.82	59961	41657	18304			
D	620	609.04	10.96	61653	43112	18541			
D	622	610.88	11.12	65036	46225	18811			
D	624	612.84	11.16	68419	49540	18879		FOS=	1.032895

* Source: Miscellaneous TVA Sources

Ft. Loudoun Lock

Case 1

Top of Gate*	818.67
Gate Sill*	777
HW Design*	815

Load Condition	HW Elev (ft)	TW Elev (ft)	HW-TW (ft)	Downstream Force (lb/ft)	Upstream Force (lb/ft)	Impact Load (lb/ft)	DS-US (lb/ft)			
A	815	-	-	45053	0	10455	55508	Design Condition		
C	819	799.4	19.62	55033	15627	-	39406			
C	820	800.7	19.327	57634	17485	-	40149			
C	821	802.3	18.729	60234	19925	-	40309			
C	822	803.3	18.71	62834	21564	-	41270			
C	823	804.4	18.569	65434	23477	-	41957			
C	824	805.7	18.337	68034	25633	-	42402			
C	825	807.0	18.048	70635	27990	-	42644		FOS=	1.301645
C	826	808.7	17.313	73235	31327	-	41908			
C	827	810.5	16.507	75835	35000	-	40835			
C	828	812.3	15.75	78435	38768	-	39667			
C	829	813.9	15.092	81035	42501	-	38535			
C	830	815.6	14.414	83636	46453	-	37183			
C	831	817.8	13.205	86236	51924	-	34312			
D	832	820.3	11.654	88836	58533	-	30303			
D	833	822.9	10.057	91436	65286	-	26150			
D	834	825.7	8.337	94037	72359	-	21678			
D	835	828.6	6.378	96637	80053	-	16584			
D	836	831.6	4.433	99237	87710	-	11527			
D	837	834.3	2.739	101837	94715	-	7122			

Case 2

Top of Gate*	818.67
Gate Sill*	777
HW Design*	815

Load Condition	HW Elev (ft)	TW Elev (ft)	HW-TW (ft)	Downstream Force (lb/ft)	Upstream Force (lb/ft)	Impact Load (lb/ft)	DS-US (lb/ft)			
A	815	-	-	45053	0	10455	55508	Design Condition		
B	819	766.5	52.458	55033	0	-	55033			
B	820	768.9	51.054	57634	0	-	57634			
B	821	771.1	49.912	60234	0	-	60234			
B	822	773.7	48.313	62834	0	-	62834			
B	823	773.7	49.254	65434	0	-	65434			
C	824	777.2	46.789	68034	1	-	68033			
C	825	780.8	44.197	70635	451	-	70183			
C	826	784.4	41.574	73235	1721	-	71514			
C	827	788.3	38.715	75835	3973	-	71862		FOS=	0.772427
C	828	791.9	36.139	78435	6890	-	71545			
C	829	795.3	33.66	81035	10494	-	70541			
C	830	798.7	31.337	83636	14642	-	68994			
C	831	802.9	28.105	86236	20921	-	65315			
C	832	807.6	24.43	88836	29157	-	59679			
C	833	812.3	20.743	91436	38783	-	52653			
C	834	817.1	16.859	94037	50273	-	43764			
D	835	822.3	12.741	96637	63507	-	33129			
D	836	827.3	8.693	99237	76633	-	22604			
D	837	832.0	5.003	101837	88828	-	13009			

No Failure Case will control since the head differential is too low

* Source: TVA Drawing 64W204, R0

Melton Hill Lock

Top of Gate*	800.44
Gate Sill*	776.75
HW Design*	795

Load Condition	HW Elev (ft)	TW Elev (ft)	HW-TW (ft)	Downstream Force (lb/ft)	Upstream Force (lb/ft)	Impact Load (lb/ft)	DS-US (lb/ft)	
A	795	-	-	10392	0	12112	33755	Design Condition
B	800.44	765.4	35.1	17510	0	-	17510	
B	802	765.9	36.1	19816	0	-	19816	
B	803	766.3	36.7	21294	0	-	21294	
B	804	766.9	37.1	22773	0	-	22773	
B	804.95	767.6	37.4	24177	0	-	24177	
B	805	767.6	37.4	24251	0	-	24251	
B	805.48	768.0	37.5	24960	0	-	24960	
B	806	768.4	37.6	25729	0	-	25729	
B	807	769.2	37.8	27207	0	-	27207	
B	808	770.2	37.8	28686	0	-	28686	
B	809	771.1	37.9	30164	0	-	30164	
B	810	772.1	37.9	31642	0	-	31642	
B	811	773.2	37.8	33120	0	-	33120	
B	811.7	773.9	37.8	34155	0	-	34155	
B	812	774.2	37.8	34599	0	-	34599	
B	813	773.1	39.9	36077	0	-	36077	
B	814	774.3	39.7	37555	0	-	37555	
B	815	775.5	39.5	39033	0	-	39033	
B	816	776.7	39.3	40512	0	-	40512	
C	816.46	777.2	39.2	41192	7	-	41185	
C	818	778.9	39.1	43468	138	-	43330	
C	819	779.8	39.2	44946	284	-	44662	
C	820	780.5	39.5	46425	445	-	45979	

* Source: TVA Drawing 64N202, R0

Alternative Analysis

Design HW*	795 ft
Hydrostatic Head on Highest Stressed Girder*	17.25 ft
Critical Combined Girder Stress	15.76 ksi
Critical Skin Plate Stress	9.28 ksi
Critical Combined Girder/Plate Stress	12.98 ksi
Maximum Girder Stress*	15.76 ksi
Allowable Steel Stress*	19.2 ksi
Maximum PMF Elevation**	820 ft

For PMF considerations, it is typical to increase the load carrying capacity of the steel by 50%.***
Therefore, Fy=28.8 ksi in this analysis.

This input produces a rough equation for estimating the headwater at which Fy will be exceeded.

[17.25ft+(PMFelev-795)]*(15.76ksi/17.25ft)=28.8 ksi

Solving this equation results in a PMF elevation of 809.27'.

The maximum stress (girder + skin plate)

[17.25ft+(820-795)]*(15.76ksi/17.25ft)=38.6 ksi at HW of 820'

Maximum Stress (girder)

[17.25ft+(820-795)]*(11.98ksi/17.25ft)=29.4 ksi at HW of 820'

Maximum Stress (plate)

[17.25ft+(820-795)]*(15.76ksi/17.25ft)=22.73 ksi at HW of 820'

See whitepaper for conclusions.

* Source: TVA Drawing 64N202, R0
**Source: TVA Calculation CDQ000020080013
***Source: WBN and SQN FSAR, Section 3.8.4.3.2

Watts Bar Lock

Top of Gate*	748.67
Gate Sill*	719.67
HW Design*	745

Load Condition	HW Elev (ft)	TW Elev (ft)	HW-TW (ft)	Downstream Force (lb/ft)	Upstream Force (lb/ft)	Impact Load (lb/ft)	DS-US (lb/ft)			
A	745	-	-	20018	0	10455	30473	Design Condition		
B	**749**	719.49	29.5	26836	0	-	26836			
C	**750**	720.23	29.8	28646	10	-	28636			
C	**752**	719.90	32.1	32265	2	-	32263			
C	**753**	719.76	33.2	34075	0	-	34075			
C	**755**	721.03	34.0	37694	58	-	37636			
C	**757**	722.38	34.6	41313	229	-	41084			
C	**759**	723.78	35.2	44932	527	-	44405			
C	**760**	724.57	35.4	46742	749	-	45993			
C	**761**	725.47	35.5	48552	1050	-	47501			
C	**762**	726.45	35.6	50361	1433	-	48928			
C	**763**	727.47	35.5	52171	1900	-	50271			
C	**764**	728.53	35.5	53980	2451	-	51529			
C	**765**	729.62	35.4	55790	3091	-	52699			
C	**766**	730.74	35.3	57600	3821	-	53778			
C	**767**	731.87	35.1	59409	4643	-	54766			
C	**768**	733.18	34.8	61219	5691	-	55527			
C	**769**	734.62	34.4	63028	6973	-	56055			
C	**770**	736.11	33.9	64838	8428	-	56410		FOS=	0.540215

* Source: TVA Drawing 64W203-1, R0

Alternative Analysis

Design HW*	745	ft
Hydrostatic Head on Highest Stressed Girder*	24.33	ft
Maximum Girder Stress*	13.77	ksi
Allowable Steel Stress*	18	ksi
Maximum PMF Elevation**	770	ft

For PMF considerations, it is typical to increase the load carrying capacity of the steel by 50%.***
Therefore, Fy=27 ksi in this analysis.

This input produces a rough equation for estimating the headwater at which Fy will be exceeded.

[24.33ft+(PMFelev-745)]*(13.77ksi/24.33ft)=27 ksi

At a PMF elevation of 770 feet, the stress in the girder is 27.92 ksi

* Source: TVA Drawing 64W203-1, R0
**Source: TVA Calculation CDQ000020080020
***Source: WBN and SQN FSAR, Section 3.8.4.3.2

Chickamauga Main Lock

Top of Gate*	689.17
Gate Sill*	662
HW Design*	682.5

Load Condition	HW Elev (ft)	TW Elev (ft)	HW-TW (ft)	Downstrean Force (lb/ft)	Upstream Force (lb/ft)	Impact Load (lb/ft)	DS-US (lb/ft)			
A	682.5	-	-	13112	0	13263	13112	Design Condition		
C	690	678.553	11.447	24439	8549	-	15890			
C	692	680.524	11.476	27830	10706	-	17124			
C	694	682.576	11.424	31221	13209	-	18012			
C	696	684.676	11.324	34612	16043	-	18569			
C	698	686.796	11.204	38003	19183	-	18820		FOS=	0.696713
C	700	688.943	11.057	41393	22649	-	18745			
D	702	691.181	10.819	44784	26442	-	18343			
D	704	693.512	10.488	48175	30394	-	17781			
D	704.8	694.474	10.326	49531	32025	-	17507			
D	706	695.499	10.501	51566	33762	-	17803			
D	708	697.619	10.381	54957	37357	-	17600			
D	710	700.347	9.653	58347	41982	-	16366			
D	712	703.414	8.586	61738	47182	-	14557			
D	714	706.704	7.296	65129	52759	-	12370			
D	716	710.073	5.927	68520	58471	-	10049			
D	718	713.43	4.57	71911	64163	-	7748			
D	720	716.391	3.609	75302	69183	-	6119			
D	722	719.038	2.962	78692	73671	-	5022			
D	724	721.511	2.489	82083	77863	-	4220			
D	726	723.858	2.142	85474	81842	-	3632			

* Source: Miscellaneous TVA Sources

Trans. ASCE, Vol. 22, pp. 190-210, 1957

AMERICAN SOCIETY OF CIVIL ENGINEERS

Founded November 5, 1852

TRANSACTIONS

Paper No. 2855

DISCHARGE COEFFICIENTS FOR SPILLWAYS AT TVA DAMS

By Kenneth W. Kirkpatrick,[1] A. M. ASCE

Synopsis

Spillway ratings derived from model studies have been used in the preparation of spillway rating tables for the Tennessee Valley Authority dams. As a result of these studies, discharge coefficients for eleven of the Tennessee Valley Authority dams are given in this paper. Coefficients for both submerged and free discharge conditions are presented for discharges over standard spillway crests, irregular spillway crests, and a vertical-lift spillway gate. Discharge coefficients for Tainter gates placed on curved spillway crests are also given for various gate openings under free discharge conditions. In addition, data on the effect of model scale on the discharge coefficient and the effect of closing adjacent spillway bays and gates are presented. The coefficient relationships are shown in a form that may be used by designers as a guide in making determinations of the discharges for future spillways.

Notation

The letter symbols adopted for use in this paper are defined where they first appear, in the illustrations or in the text, and are arranged alphabetically, for convenience of reference, in the Appendix.

Introduction

The Tennessee Valley Authority (TVA) operates a system of nine dams on the Tennessee River and twenty-three on the tributary rivers. The successful operation of such a system requires accurate discharge ratings for each structure. Although enough water is seldom available to make complete ratings for most spillways from measurements conducted on the prototype structure, ratings can be determined from scale model tests. Therefore, the necessary ratings for the TVA spillways have been determined by this means. Model studies have been made at the TVA Hydraulic Laboratory at Norris, Tenn.,

Note.—Published, essentially as printed here, in February, 1955, as *Proceedings-Separate No. 626*. Positions and titles given are those in effect when the paper was approved for publication in *Transactions*.

[1] Hydr. Engr., Hydr. Lab., Tennessee Valley Authority, Norris, Tenn.

on nine different spillway crest shapes equipped with three types of control gates.

Seven of the nine crests were curved sections which approximated the shape of the lower nappe of a sharp-crested weir. The other two crests were flat. The two flat-crested weirs and one of the curved crests were equipped with double-leaf vertical lift gates. Five of the curved crests were equipped with Tainter gates and the other with vertical lift gates.

Data Presented.—Data are presented for the following conditions: (1) Free, ungated flow through a series of spillway bays; (2) submerged, ungated flow through a series of spillway bays; (3) free, ungated flow through a series of spillway bays, with adjacent bays fully open or closed; (4) free flow over a vertical lift gate; (5) submerged flow over a vertical lift gate; (6) flow under a series of Tainter gates set with equal openings; and (7) flow under a series of Tainter gates with adjacent gates closed.

Data are also presented to show the effect of model scale for the condition of free, ungated flow through a series of spillway bays.

General Model Arrangement.—The models were tested in flumes either 3.5 ft wide or 8 ft wide. Models installed in the smaller flume usually consisted of a reproduction of three of the prototype spillway bays. In the larger flume five or six spillway bays were reproduced. Each of these flumes was provided with glass panels for observation purposes. The models placed in the larger flume were constructed at scale ratios of from 1:28.72 to 1:50 with a ratio of approximately 1:35 generally used. Those tested in the smaller flume were built at scale ratios of 1:50, 1:100, and 1:200.

The models were usually provided with concrete crests and concrete piers to insure dimensional stability. Half piers were constructed on the ends of each model. If the model did not completely fill the flume one side was placed against the glass side of the flume and the other against a false wall. The river bed upstream and downstream from the model was reproduced at the elevation of the prototype river bed. Suitable baffling was provided to obtain a uniform distribution of flow in the spillway approach channel. The tailwater level was controlled at the end of the flumes by means of slat gates. Model discharges were determined from readings of a carefully calibrated diaphragm orifice located in the water supply line.

Headwater heights were measured at two piezometers at distances equal to approximately 5 and 8 times the design head upstream from the spillway crest. Tailwater heights were obtained at 2 piezometers at distances equal to approximately 9 and 12 times the design head downstream from the spillway crest—in all cases, sufficiently far enough downstream to eliminate the effect of the spillway apron.

In most studies the headwater and tailwater levels were determined by means of hook gages reading to 0.001 ft. For the 1/200-scale model the heads were measured with a micrometer point gage reading to 0.0001 ft.

Discharge Equations.—The model data have been reduced by the use of two commonly accepted discharge equations. For both free and submerged flow over a spillway crest the equation,

$$Q = C\,L\,H^{3/2} \qquad (1)$$

was used, in which Q is the discharge in cubic feet per second, C is the coefficient of discharge determined from the model tests, L is the length of the crest, and H is the total head as shown in Fig. 1(*a*). Use was made of the same equation in the reduction of the data for free and submerged flows over a vertical gate with D, H, d, and P (Fig. 1(*a*)) being measured from the top of the gate.

For flow under a gate the equation for a rectangular orifice under low head,

$$Q = C L [H^{3/2} - (D_1 + h)^{3/2}] \qquad (2)$$

was used, in which D_1 is the depth of water to the bottom of the gate as defined in Fig. 1(*b*) and h is the approach velocity head.

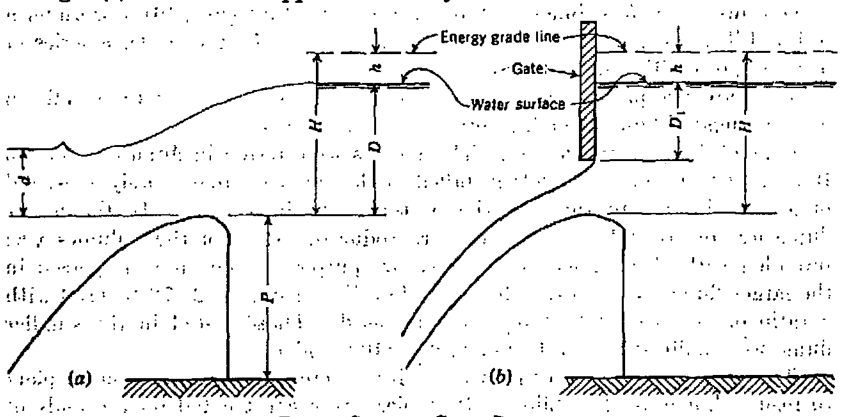

Fig. 1.—Spillway-Crest Diagram

Free-Discharge Coefficients, Flow over Spillway Crests

It is common practice for engineers to design spillway crests to approximate closely the shape of the lower portion of a jet issuing from a sharp-crested weir, and this type of crest is designated a standard crest.[2] Because the shape of the jet changes with the head on the weir, some particular head must be used for each design. This head for which a particular crest is designed is termed the design head. At this head, pressures approximating atmospheric pressure are developed at the spillway surface. At smaller heads, pressures are greater than atmospheric. Seven of the nine TVA crests for which data are available approximate standard crests in shape whereas the other two crests, which are flat, do not. Fig. 2 shows the basic details and dimensions of each of these crests. Fig. 3 presents the coefficient data obtained on the crests of Fig. 2. Pertinent design data concerning each crest, together with the scale to which each was modeled, appear in Table 1. Eleven spillways are also listed in Table 1. Two pairs of these, the Ocoee No. 3-Apalachia set, and the Douglas-Watts Bar set, both in Tennessee, have crest shapes that are identical within the pair but which were tested for different values of the approach depth, P.

[2] "Hydroelectric Handbook," by W. P. Creager and J. D. Justin, John Wiley & Sons, Inc., New York, N. Y., 2d Ed., 1950.

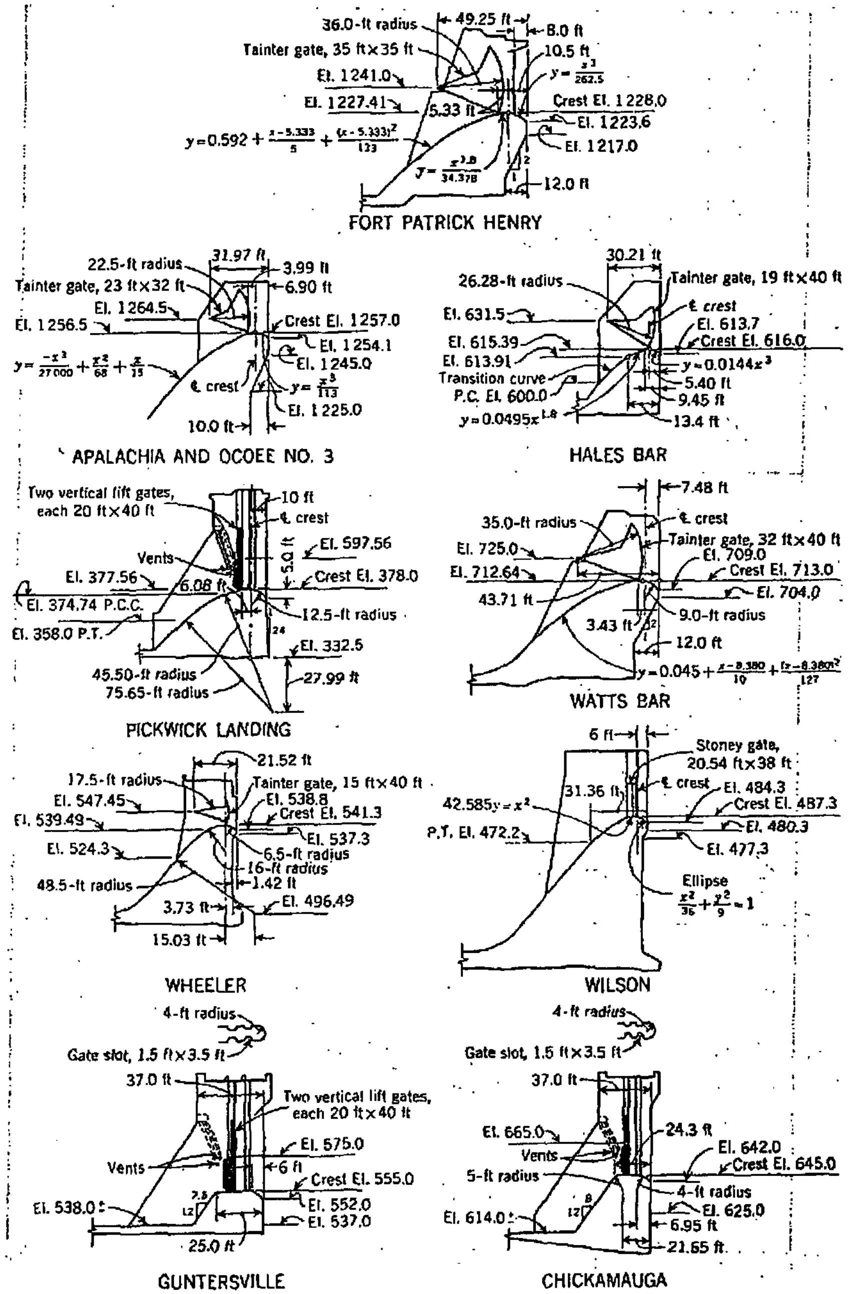

Fig. 2.—TVA Spillway Crests (Data in Fig. 3)

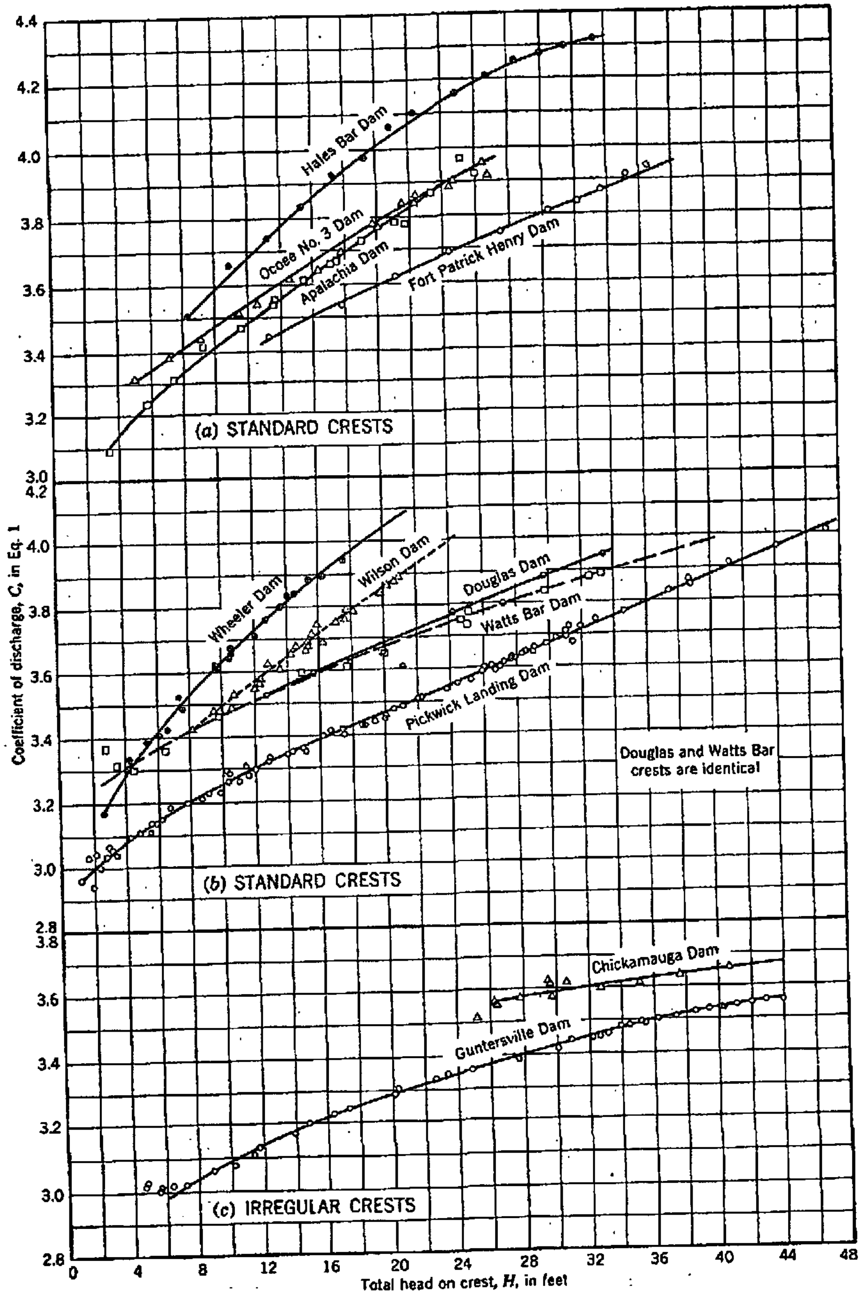

FIG. 3.—DISCHARGE COEFFICIENTS FOR FREE FLOW OVER THE SPILLWAY CRESTS OF FIG. 2

The accuracy of the data is evidenced by the plotting of the data points in Fig. 3. Except in some cases at low heads, the deviation of any plotted point from the coefficient curve does not exceed 0.5%.

Standard Crests.—It has been shown by various authors that the discharge coefficients for all standard crests can be related to each other and that, conversely, the coefficients to be used for a new design can be taken from previous test data.[2,3,4,5] Unfortunately, in most crest designs, due to other design considerations, it is necessary that the shape be varied from the standard form. Nevertheless, satisfactory coefficients can be obtained as sufficient data are now available on a range of crest shapes. By comparison of crest shapes designers may select a coefficient for any particular crest.

Dimensionless plotting provides a means for comparison of crest shapes. This method is used in Fig. 4 on which seven TVA crests which closely approximate standard crests are shown by the solid lines, with the dashed line representing a standard crest shape.[2] The horizontal coordinate, x, and the vertical coordinate, y, of the crest curve have been divided by the design head, H_o.

TABLE 1.—DESIGN DATA FOR ELEVEN MODELS OF TVA SPILLWAYS

Project	Model scale	Design head, H_o, in feet	Upstream depth, P, in feet	$\frac{H_o}{P}$	Pier nose radius, in feet
Hales Bar	1:34.76	18	32	0.56	3.00
Ocoee No. 3	1:28.72	23	67	0.35	3.00
Apalachia	1:28.72	23	97	0.24	3.00
Fort Patrick Henry	1:50	35	43	0.81	3.25
Wheeler	1:34.35	16.5	43	0.38	2.50
Wilson	1:39.4	19	75	0.25	4.00
Douglas	1:35	23.5	133	0.18	3.25
Watts Bar	1:35	23.5	52	0.45	3.25
Pickwick Landing	1:50	31.5	32	0.98	3.75
Chickamauga	1:50		20		4.00
Guntersville	1:50		18		4.00

The design head was determined by fitting the real and standard curves at the crest point ($x = 0$) and at the intersection of the curve with the upstream vertical face. These design-head values are presented in Table 1. The design-head discharge coefficients (C_o) determined from Fig. 3 are shown in Fig. 4.

The TVA crests all fairly closely approximate the standard curve from the upstream spillway face to a point somewhere downstream from the crest which was determined by the position of the gate seal. Below this latter point, the crest shape was modified to fit the trajectory of a jet issuing from under the gate when set at a small opening. The upstream face for a standard crest is vertical. The upstream face of the TVA crests, as shown in Fig. 4, deviates from the vertical. Other experimenters have established the fact that the shape of the upstream face generally has little influence on the discharge coefficient.[3]

[3] "Final Reports of Boulder Canyon Project," *Bulletin No. 8*, Part VI, Hydraulic Investigations, Bureau of Reclamation, U. S. Dept. of the Interior, Washington, D. C., 1947.

[4] "Engineering Hydraulics," edited by Hunter Rouse, John Wiley & Sons, Inc., New York, N. Y., 1950.

[5] "Discharge Coefficients for Irregular Overfall Spillways," by J. N. Bradley, *Engineering Monograph No. 9*, Bureau of Reclamation, U. S. Dept. of the Interior, Washington, D. C., 1952.

Fig. 4 indicates that the shape of the curve from the crest to a point somewhere in the neighborhood of $x/H_o = 0.5$ materially affects the coefficient. As the curve is raised above the standard curve, the coefficient is decreased. This can be seen by comparing the (y/H_o)-values at $x/H_o = 0.5$ with C_o. The comparative crests in Fig. 4 have been placed in the order of decreasing (Y/H_o)-values. No reasonable correlation of C_o with either upstream shape of H_o/P can be determined.

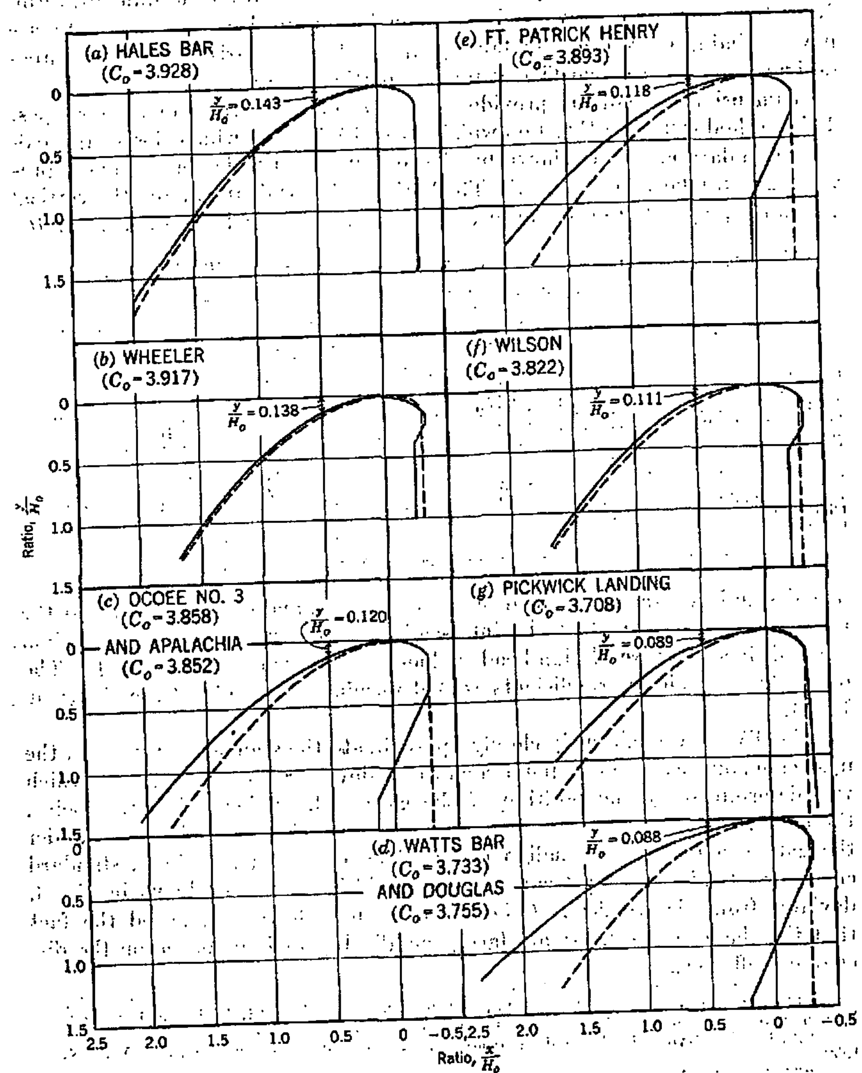

Fig. 4.—Comparative Crests (H_o/P Shown in Table 1)

The relationships between the discharge coefficient and the ratio of any head to the design head, H/H_o, are shown in Fig. 5. In Fig. 5(a) the value of C is plotted against H/H_o for the four crests—Apalachia, Ocoee No. 3, Hales Bar (Tennessee), and Fort Patrick Henry (Tennesse)—that most closely follow the standard crest shape. The maximum variation of the individual points from

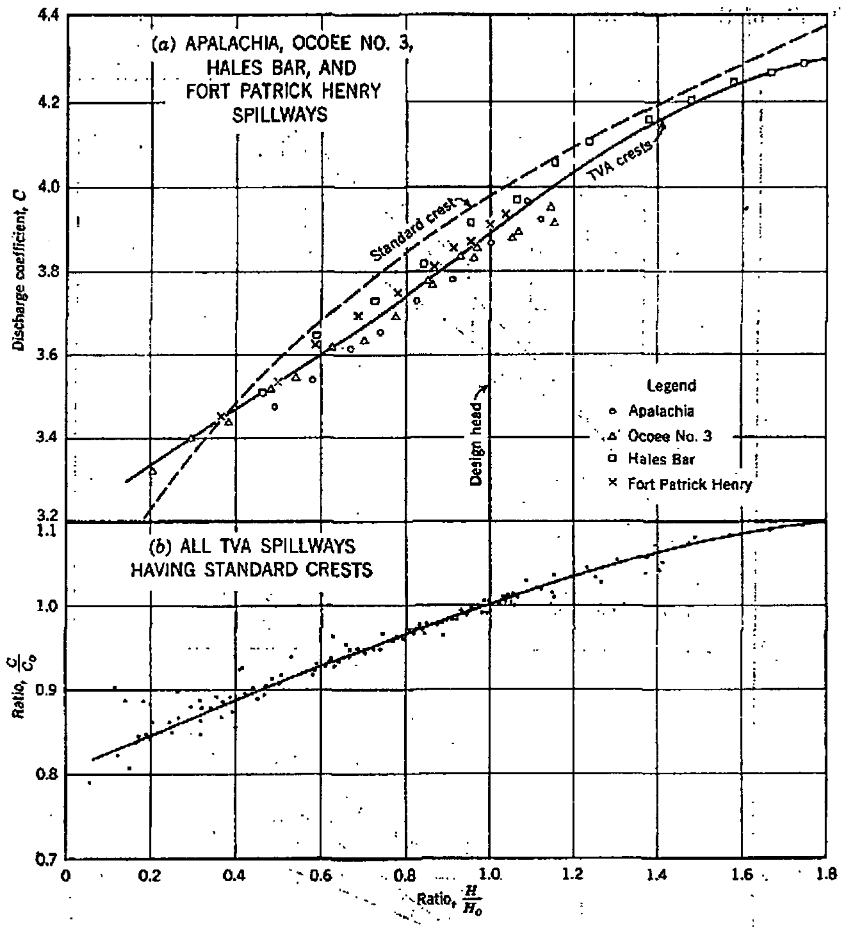

Fig. 5.—Discharge Coefficients for Spillways Having Standard Crests

the average curve for TVA crests is 0.5%. The standard-crest curve shown by the dashed line in Fig. 5 is that of W. P. Creager and J. D. Justin.[3] This curve is approximately 2% higher than the TVA curve. Fig. 5(b) is a dimensionless plot of the data from Figs. 3(a) and 3(b). The deviation of the points from the average curve is greater than in Fig. 5(a) because all crests are included, but for design purposes the curve should be useful. Actually, the curve is more firmly established than it may appear because the curve itself obliterates several test points.

Irregular Spillway Crests.—The designation "irregular spillway crests" is used to distinguish between standard spillway crests and other crest forms. Only two of the TVA spillways, those at Chickamauga, Tenn., and Guntersville, Ala., have irregular spillway crests. Both are trapezoidal in cross section. Details of these spillway crests and the discharge coefficients computed using

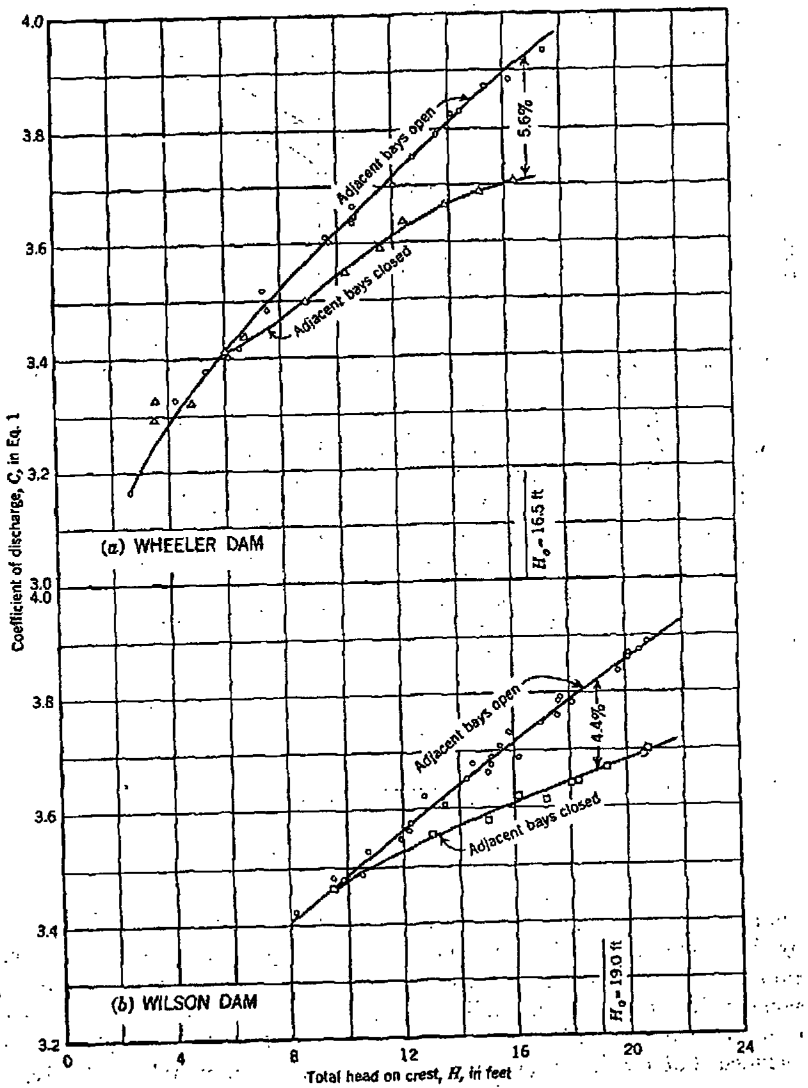

FIG. 6.—EFFECT OF OPERATION OF ADJACENT SPILLWAY BAYS

Eq. 1 from the model-study data are shown in Fig. 3(*c*). The two crests differ chiefly in the shape of the upstream and downstream edges of the crest and the height above the apron. Over the range of the tests of the Chickamauga spillway the coefficients are consistently from 3% to 5% greater than those for the Guntersville spillway. The additional height of the crest above the apron and the rounding of the near upstream edge of the Chickamauga crest would operate to increase the discharge coefficients.

The Effect of Operating Adjacent Spillway Bays.—In the TVA water-control operations, it is necessary to operate single spillway bays and groups of consecutive spillway bays. Because a greater contraction forms at a pier situated next to a closed bay, models of the Wilson and Wheeler spillways in Tennessee were tested with adjacent spillway bays open and closed to determine the difference in contraction effects at the piers.

Fig. 6 shows the head-coefficient relationships for the two conditions tested. The discharge coefficient at the design head was 5.6% higher at Wheeler Dam with adjacent bays opened and 4.4% higher at Wilson Dam than with these bays closed. These relationships show the importance of spillway pier contraction effects in spillway discharge determinations.

SUBMERGENCE DISCHARGE COEFFICIENTS FOR FLOW OVER SPILLWAY CRESTS

Chickamauga Dam, Guntersville Dam, Pickwick Landing Dam (Tennessee), and Watts Bar Dam are subject to submergence of the crest at periods of high discharge. To determine the effect of this submergence model tests were conducted by establishing a constant rate of discharge and varying the tailwater elevation to determine the relationship between the headwater and tailwater elevations. This procedure was repeated for several discharge rates covering the operating range at the dam.

Two flow conditions were observed in the model tests which are characterized as "plunging nappe" and "flowing nappe." In the condition of plunging nappe the discharge issuing from the spillway plunges down into the tailwater and appears to follow the boundary surface of the spillway.

In the condition of flowing nappe the flow is nearly horizontal, producing an undulating surface flow in the tailrace channel. The plunging nappe usually occurs with low submergence whereas the flowing nappe occurs with high submergence. When the headwater and tailwater head relationship at a constant rate of discharge was plotted for each series of tests, it was found that the change from plunging nappe to flowing nappe had no apparent effect on the discharge coefficient.

The results from these tests on the four spillways have been plotted in Fig. 7 in the dimensionless form, d/H, against C_s/C, in which d is the depth of submergence and H is the total head above the crest. The coefficient, C_s, was computed from Eq. 1 using the H-value for the submerged conditions; C was determined using the H-value for the free-flow condition.

No systematic variation of C_s/C could be determined for any variable except the (d/H)-ratio for any of the conditions tested. However, no relatively low discharges were tested because in practice the TVA installations can never be submerged at low discharges.

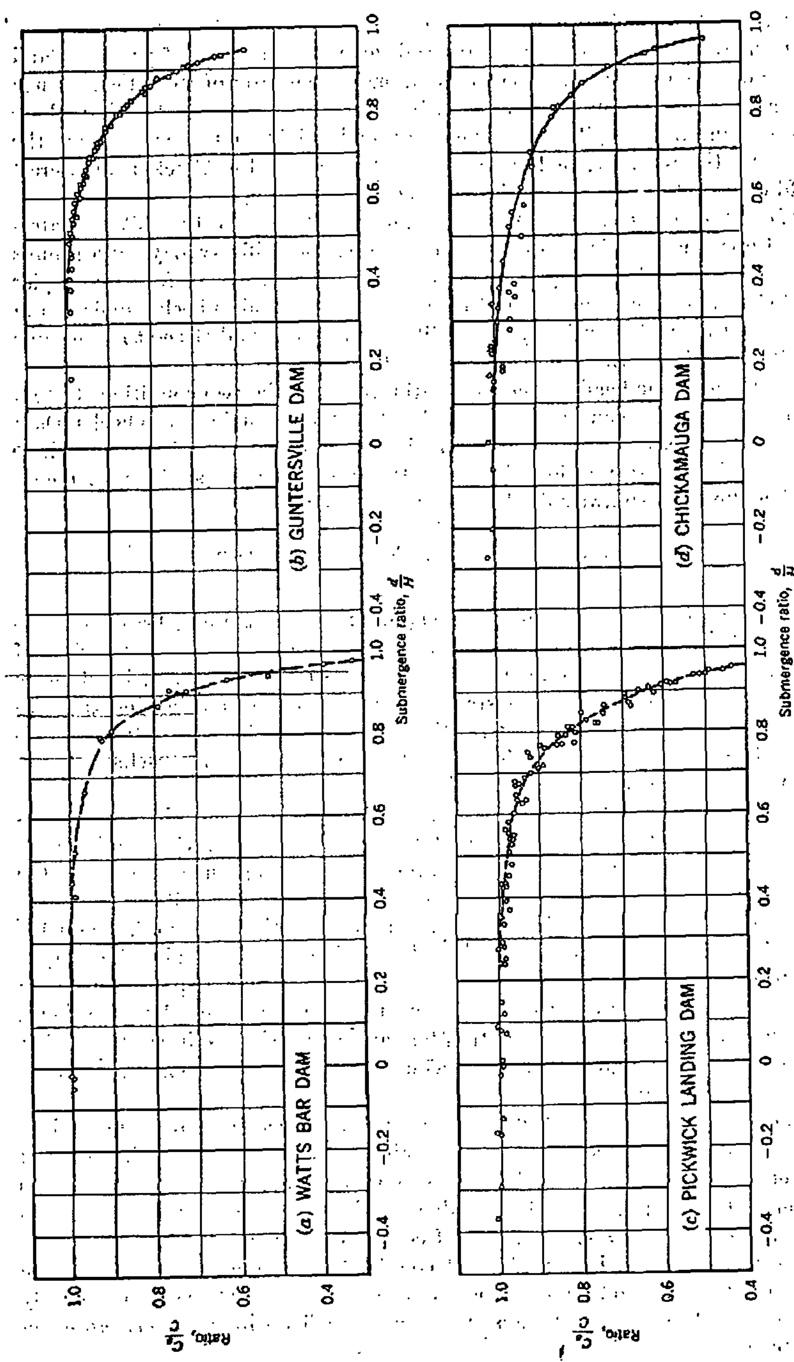

FIG. 7.—EFFECT OF SUBMERGENCE ON DISCHARGE COEFFICIENTS (C-VALUES FROM FIG. 3)

In Fig. 8 the four curves of Fig. 7 are shown on a single plot. Although the maximum spread between curves is about 10%, this is to be expected considering the wide range of crest shapes used in the tests.

FREE-DISCHARGE COEFFICIENTS FOR FLOW OVER VERTICAL LIFT GATES

The Pickwick Landing vertical lift gates are representative of this type of gate, which has been used on several TVA projects. In Fig. 9(*a*) are shown details of the lower spillway gate leaf. For heads greater than 2 ft, this gate is essentially a sharp-crested weir 40 ft long and 20 ft high with piers 7.5 ft thick at each end of the gate. Air intakes were installed in the sides of the piers just below the top of the gate to ventilate the underside of the nappe.[6] Model tests were conducted with the 1/50-scale, 3-bay spillway model.

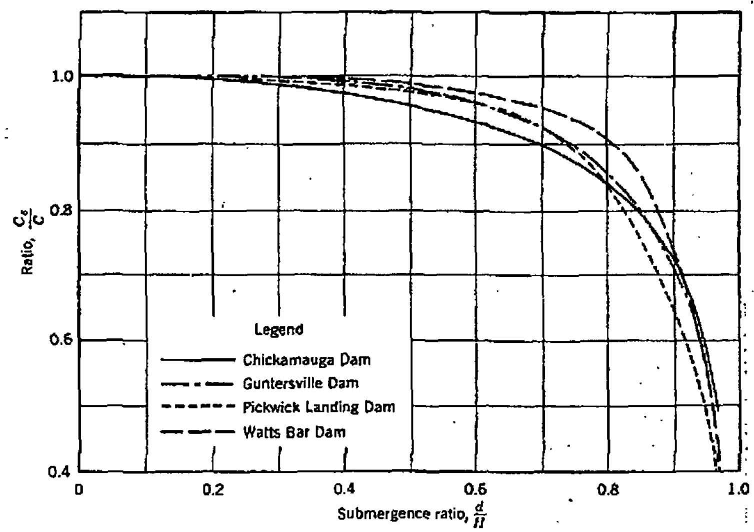

FIG. 8.—COMPARISON OF SUBMERGENCE EFFECTS FOR VARIOUS SPILLWAY CREST SHAPES

In Fig. 9(*b*) is shown the head-coefficient relationship for flow over the crest of the spillway gate. The coefficient, C, was computed from Eq. 1 using the top of the gate as crest elevation. The points define the head-coefficient relationship for heads between 3 ft and 28 ft. Each point was determined from the average of from 3 to 5 separate tests. A constant value of C equal to 3.428 is shown for heads in excess of 12 ft. For heads of from 12 ft to about 4 ft the model test curve shows a gradual rise in the coefficient, with an abrupt drop-off when the heads are approximately 4 ft and less. This curve takes the characteristic form for the coefficients of a sharp-crested weir, the rise and fall in the coefficient curve being due to the nappe clinging to the surface of the weir. This phenomenon is a function of the absolute head. Therefore, similarity between the model and prototype did not exist for prototype heads

[6] "Aeration of Spillways," by G. H. Hickox, *Transactions*, ASCE, Vol. 109, p. 537.

of less than 12 ft. Because the gate has a 10-in.-wide flat top, at low heads the prototype can be expected to exhibit discharge characteristics similar to those of the model. However, for a head in excess of about 2 ft the prototype can be expected to act similarly to a sharp-crested weir and to have a flat coefficient curve.

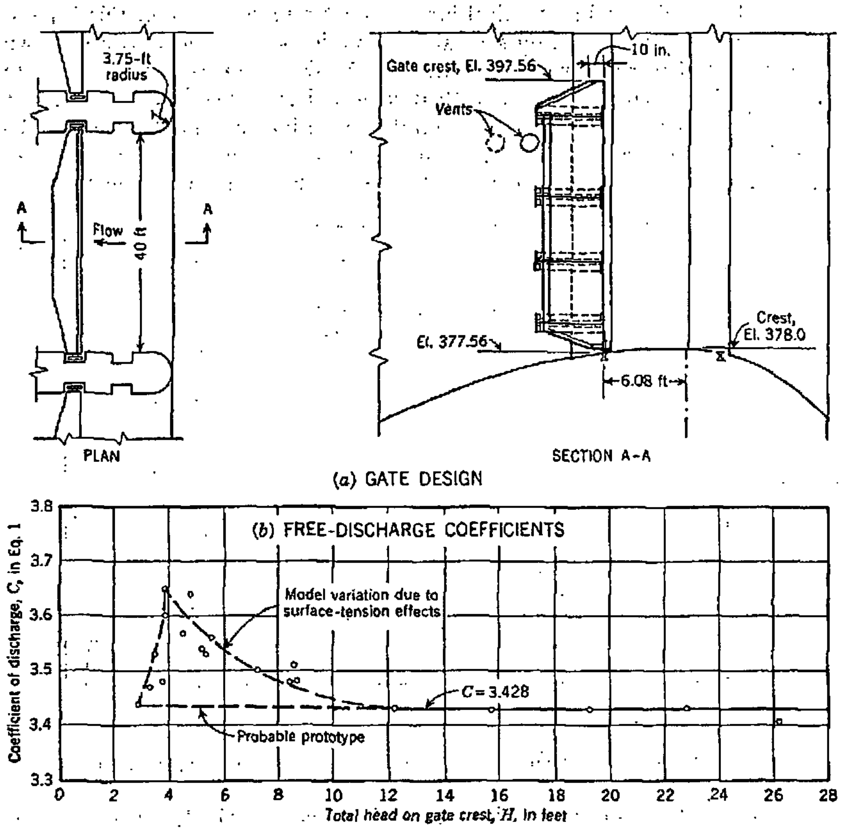

FIG. 9.—VERTICAL LIFT GATE, PICKWICK LANDING DAM

SUBMERGENCE DISCHARGE COEFFICIENTS FOR FLOW OVER A VERTICAL LIFT GATE

To obtain data on the effect of the submergence of flow over vertical-lift gates, model tests were conducted in a manner similar to that used in determining submergence effects on spillway crests. The coefficient, C_s, was computed from Eq. 1 in a manner similar to that used for the spillway crest data but using the top of gate as the crest elevation. Fig. 10 shows a plot of the headwater-tailwater relationships that have been determined. The data presented in Fig. 10 represent the rating of a three-bay, 1/50-scale model of the Pickwick Landing Dam. The total equivalent prototype crest width was

117.8 ft. The discharge was for three spillway bays. These curves illustrate the characteristic flow phenomena associated with this type of gate. Each constant-discharge curve begins with a horizontal line where the head-discharge relationship is not affected by the tailwater level. Just before the tailwater elevation reaches the gate crest level there is a drop in the headwater

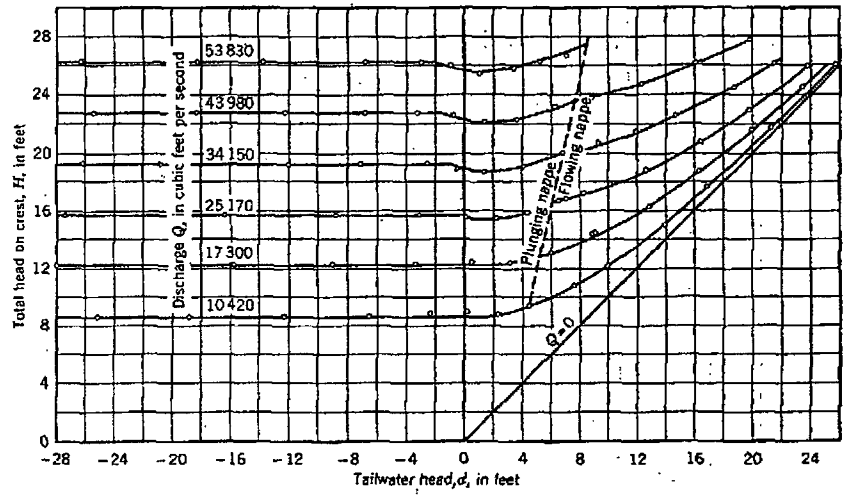

FIG. 10.—HEADWATER-TAILWATER RELATIONS FOR FLOW OVER A VERTICAL LIFT GATE (PROFILE SKETCH IN FIG. 11)

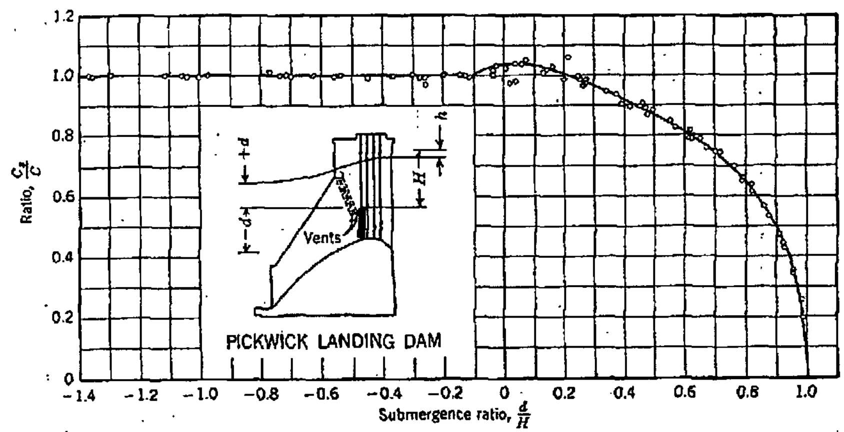

FIG. 11.—SUBMERGENCE EFFECT FOR FLOW OVER A VERTICAL LIFT SPILLWAY GATE ($C = 3.428$)

level for an increase in the tailwater level. Observations of the model operation showed that at this point the air vents, located in the sides of the piers just below the crest of the spillway gate, became submerged by the tailwater, reducing the contraction of the lower nappe issuing from the gate crest. The

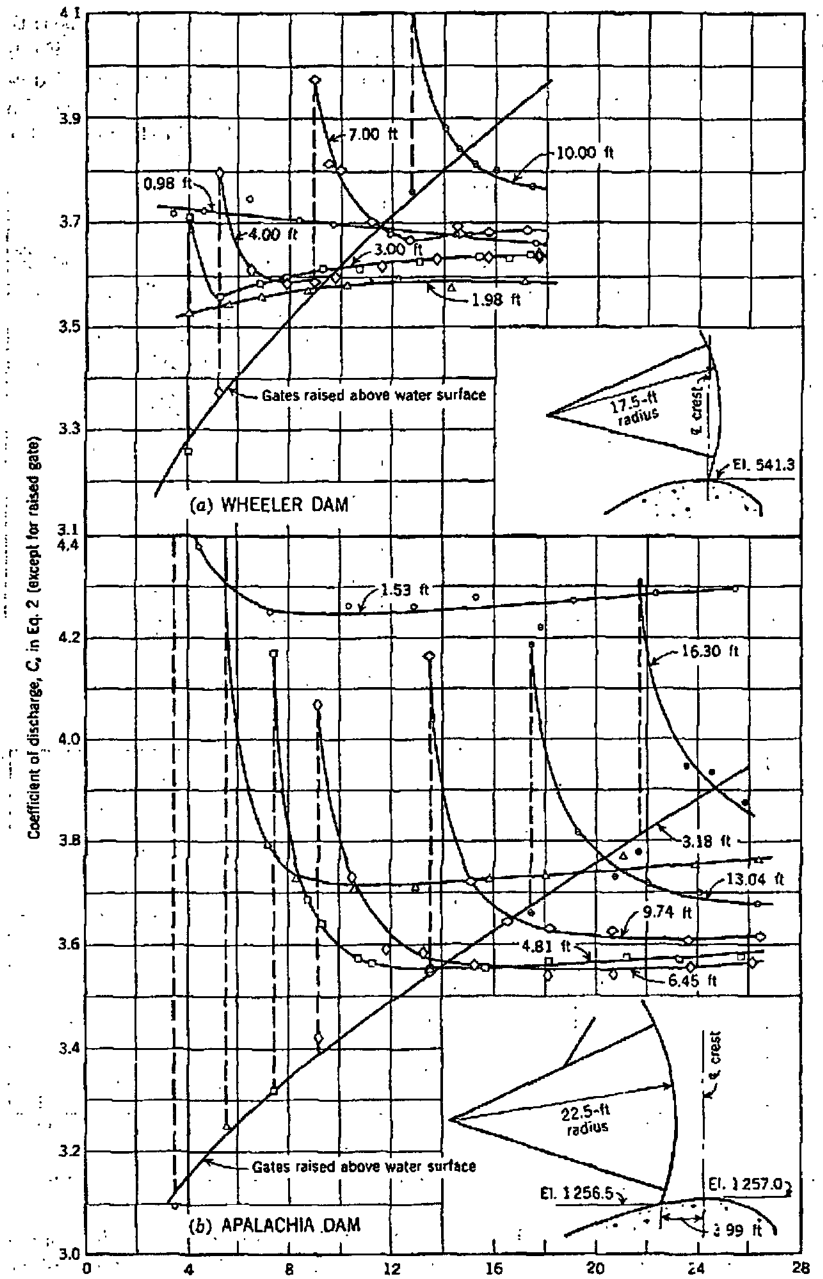

Fig. 12.—Tainter-Gate Spillway Discharge Coefficients (Dimensions on Curves Are Gate Openings)

discharge over the gate was thus increased with a consequent lowering of the headwater level.

The flow conditions of plunging nappe and flowing nappe, previously described, also occurred in this type of flow. In this case the change from one to the other is apparent in the data. The dashed line in Fig. 10 indicates the approximate location of the change. At these points the curves show a definite discontinuity in shape. The data of Fig. 10 can be reduced in coeffi-

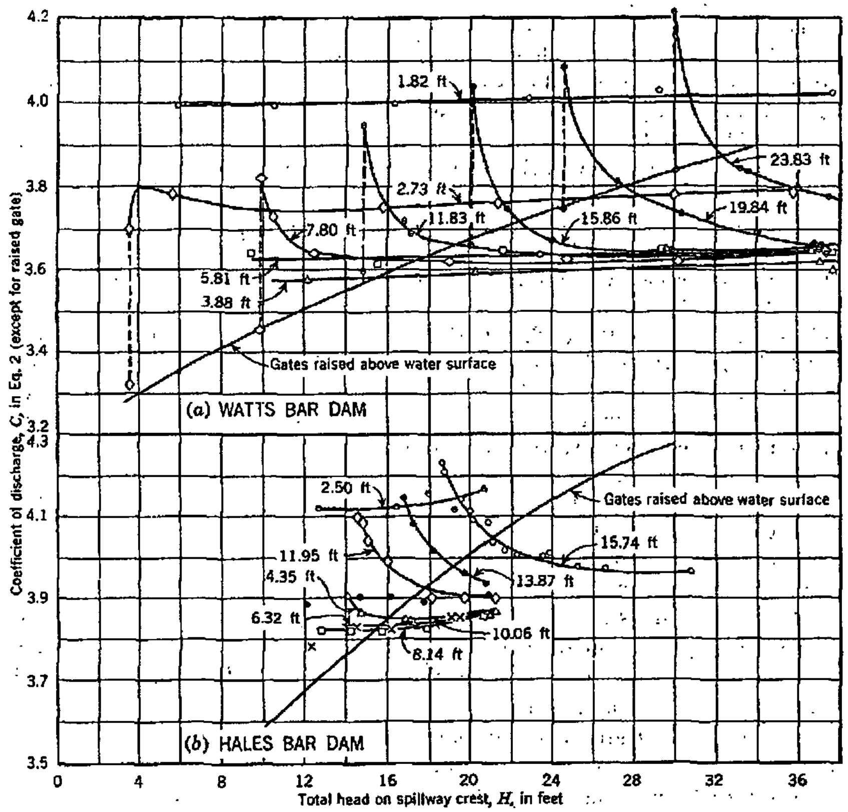

Fig. 13.—Tainter-Gate Spillway Discharge Coefficients (Dimensions on Curves Are Gate Openings)

cient form to the single-curve representation shown in Fig. 11. In this illustration, a constant value of C, equal to 3.428, was used in computing the ratio of C_s/C.

Discharge Coefficients for Flow Under Tainter Gates

The flow under Tainter gates mounted on curved crests is controlled by the geometry of three interrelated variables—the crest shape, the gate, and the gate setting. The major factors which influence the discharge relationships are the position of the gate seal point with respect to the highest point of the spillway crest and the curvature of the upstream face of the gate. In obtaining the model data on the various TVA Tainter-gate installations no attempt has been made to determine the quantitative effect of these factors taken individually. The data presented in Figs. 12 and 13 for the gate settings at Wheeler Dam, Apalachia Dam, Watts Bar Dam, and Hales Bar Dam are not, therefore, applicable to other installations unless the several variables involved are similar.

Data on Tainter-gate coefficients previously published have, in most cases, been based on flow along a horizontal surface although many of these gates are installed on curved crests. The tests reported herein are for Tainter gates mounted on curved spillway crests where the pressure distribution differs considerably from that in a horizontal channel. The coefficients obtained from tests on a horizontal channel are not applicable to installations on curved crests.

The discharge coefficients for Figs. 12 and 13 were computed using Eq. 2, with the heads measured above the crest elevation. The curves designated "Gates raised above water surface" are the free-discharge curves taken from Figs. 3(*a*) and 3(*b*) for which *C*-values were computed using Eq. 1. The points connected by the dashed lines represent the point at which the water touched the bottom edge of the gate. The difference in the *C*-values is, of course, due to the use of Eq. 2 for the gate curve. The Hales Bar tests were not conducted in a manner that allowed the determination of the point of contact of the gate with the free water surface.

The gate opening was measured as the vertical distance above the crest. This definition leads to the somewhat peculiar variation in the coefficients for small gate openings. In Fig. 12(*a*) the data for Wheeler Dam are presented. The Wheeler gate was positioned, as shown in the insert, with the seal at the high point on the crest. With this design, except at the smallest opening, the coefficient curves for each gate position followed the general pattern of an increase in *C* for an increase in gate opening. In Fig. 12(*b*) the data for Apalachia Dam indicate that, when the gate seal is 3.99 ft downstream and 0.50 ft below the highest point on the crest, the coefficients for gate openings of less than 6.45 ft are increased materially with a decrease in gate opening. This is caused by an arbitrary use in Eq. 2 of an *H*-value as measured above the crest rather than as measured above the elevation of the spillway surface below the gate. Thus, although the *H*-value is consistently too small at the smaller gate openings, the effect becomes more appreciable and results in the increase in *C*.

Tainter-Gate Discharge Coefficients with Adjacent Gates Opened or Closed

The results of tests on the six-spillway-bay model of Wheeler Dam with one gate in operation and with six gates in operation are shown in Fig. 14. In operating with all six gates the contraction effect of the end piers was the same as that for the intermediate piers because the model was constructed

with half piers against the sidewalls of the flume. This operation thus represented the case in which all adjacent bays are open.

Effect of Model Scale on Free-Discharge Coefficients

In developing discharge ratings for prototype structures from model data, it is important that the scale at which the model is built be such that the coefficients determined are applicable to the prototype structure. One author has presented data to indicate that with an increase in the model size the discharge coefficients increase.[7] To study this relationship, a series of precise

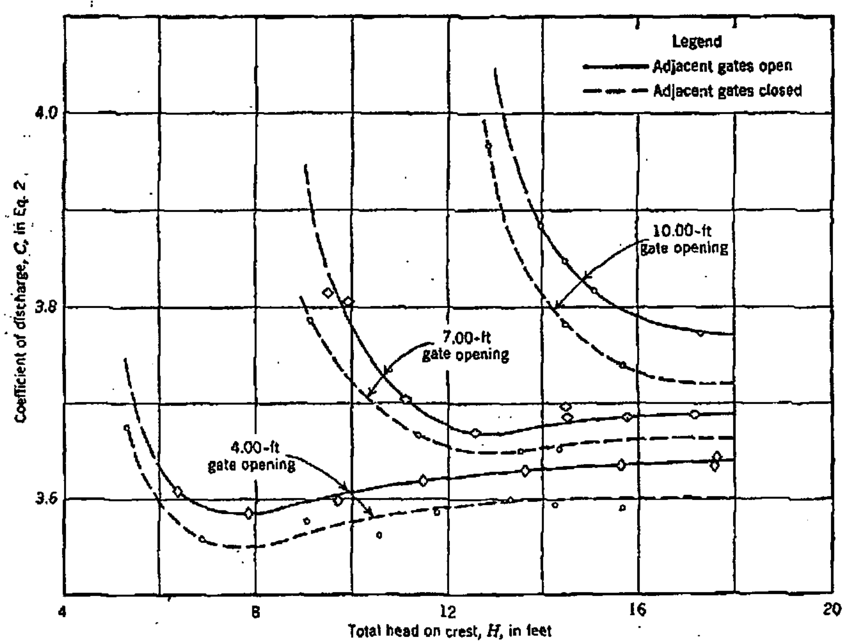

FIG. 14.—TAINTER-GATE DISCHARGE COEFFICIENTS, *C*, WHEELER DAM

tests was made at the TVA Hydraulic Laboratory under the joint sponsorship of the American Society for Engineering Education, the University of Tennessee (Knoxville) and the TVA.[8] In this study three models of Pickwick Landing spillway were constructed to scales of 1:50, 1:100, and 1:200. Each model consisted of a reproduction of three spillway bays. The shape of the spillway crest and the piers of Pickwick Landing Dam are shown in Figs. 2 and 9(*a*). Similar techniques were used in all tests with one exception. Hook gages reading to 0.0001 ft were used for the 1/200-scale

[7] "Überfallversuche in Berschiedener Modellgrosse," by F. Eisner, The Prussian Experiment Station for Hydraulic Structures and Shipbuilding, Berlin, 1933.

[8] "A Study of the Effect of Model Size on Spillway Coefficients," by C. R. Ownbey, thesis presented in 1949 to the University of Tennessee at Knoxville, in partial fulfilment of the requirements for the degree of Master of Science.

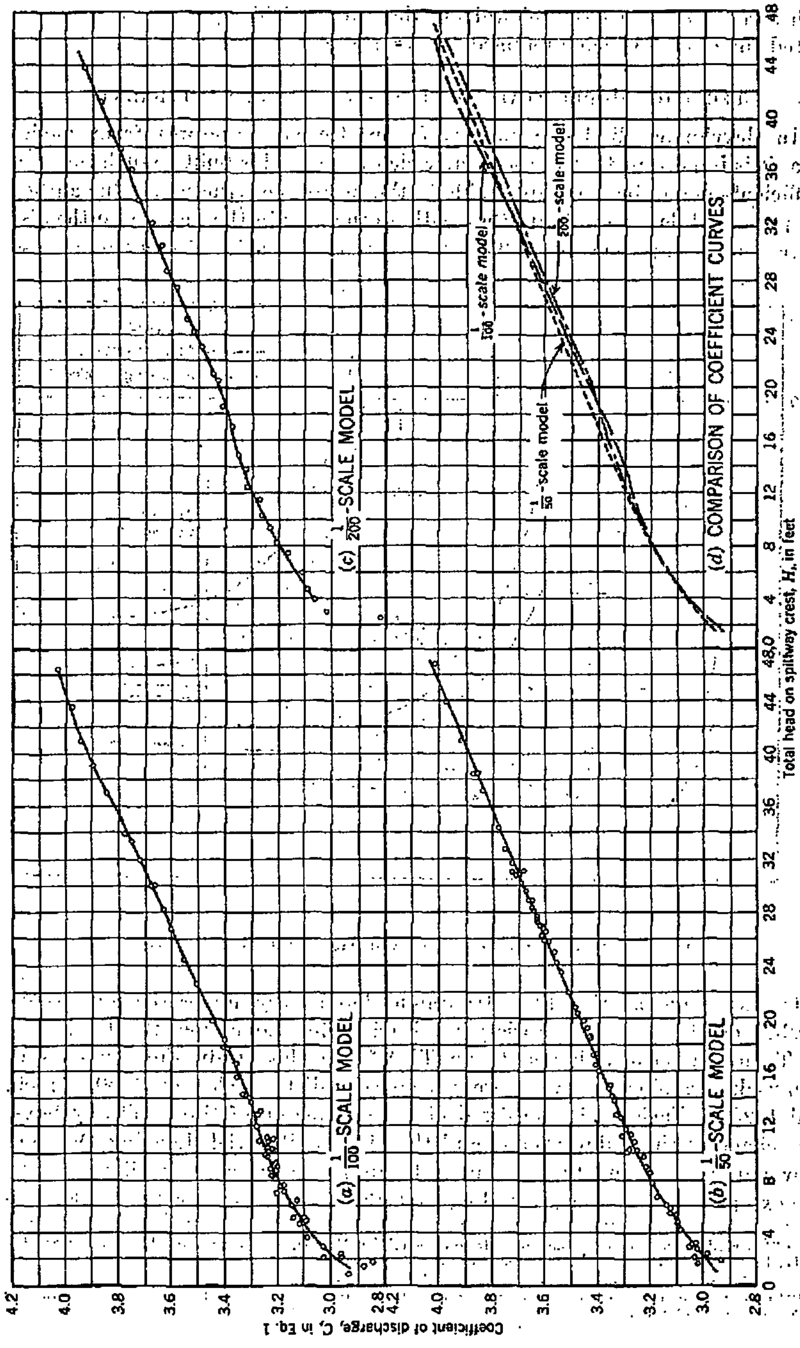

FIG. 15.—EFFECT OF MODEL SCALE ON DISCHARGE COEFFICIENTS, FLOW OVER PICKWICK LANDING SPILLWAY CREST

tests, and gages reading to 0.001 ft were used in the 1/50-scale tests and 1/100-scale tests.

Discharge coefficients for free flow over the crest of each model are shown in Figs. 15(*a*), 15(*b*), and 15(*c*). The coefficients of discharge were computed using Eq. 1. Each curve was drawn through the average of the plotted points.

A comparison of the three coefficient curves is shown in Fig. 15(*d*). The maximum spread of the curves does not exceed 2%. For prototype heads between 2 ft and 8 ft, the three coefficient curves are almost identical. At 13 ft the coefficient curve for the 1/100-scale model is approximately 1% lower than those for the 1/50-scale model and the 1/200-scale model. At 43 ft the curve for the 1/100-scale model is 1% higher than the data for the 1/50-scale model, and that of the 1/200-scale model is 1% lower than that of the 1/50-scale model. Because there is no consistent relationship between the coefficient curves, it is logical to conclude that these variations are merely the result of experimental error and that the model scale did not affect the stage-coefficient relationship. The close agreement of the coefficient curves at the three scales supports the validity of the preparation of prototype ratings based on model tests.

ACKNOWLEDGMENTS

The model studies were made under the general direction of Albert S. Fry, M. ASCE, chief of the Hydraulic Data Branch of the TVA, and under the immediate supervision of G. H. Hickox, M. ASCE, former head of the TVA Hydraulic Laboratory, and Rex A. Elder, M. ASCE, head of the TVA Hydraulic Laboratory. The assistance of Jack C. Jones, J. M. ASCE, is acknowledged in making the computations and preparing the illustrations in this paper. The writer also acknowledges the many helpful suggestions made by Mr. Hickox and Mr. Elder.

APPENDIX. NOTATION

The following letter symbols, adopted for use in the paper and for the guidance of discussers, conform essentially with American Standard Letter Symbols for Hydraulics (ASA-Z10.2-1942), prepared by a committee of the American Standards Association with Society representation, and approved by the Association in 1942:

C = coefficient of discharge for any head:
- C_o = coefficient of discharge for the design head;
- C_s = coefficient of discharge for submerged flow;

D = depth of flow above the crest, in feet (Fig. 1(*a*));

D_1 = depth, bottom of gate to water surface, in feet (Fig. 1(*b*));

d = submergence tailwater, measured above the crest, in feet (Fig. 1(*a*));

g = acceleration due to gravity, in feet per second per second;